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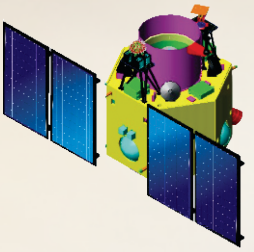

उपग्रह

Upagrah

News Letter

Vol. 46, Issue 1
Jan-Mar, 2017

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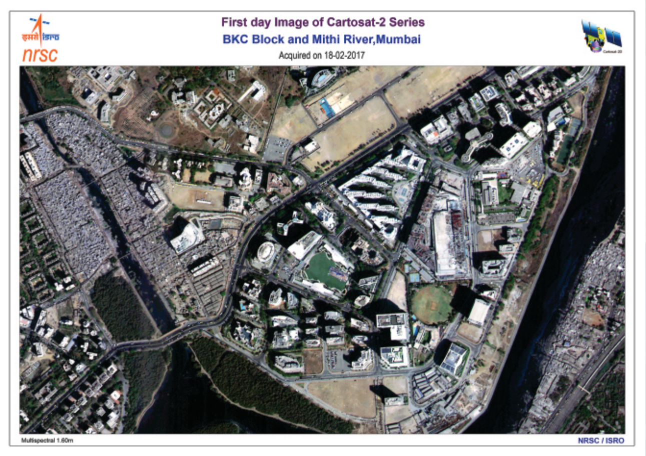
ವಿಮಾನಪುರ, ಬೆಂಗಳೂರು – 17

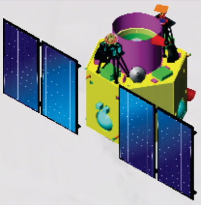
इसरो उपग्रह केंद्र
विमानपुर, बेंगलूरु – 17

ISRO SATELLITE CENTRE
VIMANAPURA, BENGALURU - 17

CARTOSAT -2 SERIES SATELLITE

Cartosat-2 Series Satellite was successfully launched on Wednesday, February 15, 2017 at 9:28 Hrs IST from SDSC SHAR, Sriharikota abord PSLV-C37


First day Image of Cartosat-2 Series
BKC Block and Mithi River,Mumbai
Acquired on 18-02-2017
Multispectral 1.60m
NRSC / ISRO



The Cartosat-2 series satellite is the primary satellite carried by PSLV-C37. This satellite is similar to the earlier four satellites of the Cartosat-2 series. After its injection into a 505 km polar Sun Synchronous Orbit by PSLV-C37, the satellite was brought to operational configuration following which it began providing regular remote sensing services using its Panchromatic and Multi-spectral cameras.

The imageries from Cartosat-2 series satellite will be useful for cartographic applications, urban and rural applications, coastal land use and regulation, utility management like road network monitoring, water distribution, creation of land use maps, change detection to bring out geographical and manmade features and various other Land Information System (LIS) and Geographical Information System (GIS) applications.

Congratulations to team PSLV for having set a record by launching 104 satellites in a single launch in the mission PSLV C37, making ISRO proud.

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Hearty Congratulations to

Prof. U R Rao

Padma Vibhushan Award

On being conferred with "Padma Vibhushan" award for 2017

IRNSS-1E COMPLETES ONE YEAR IN ORBIT

IRNSS-1E, the fifth spacecraft Indigenous Navigation System i.e., of Navigation with Indian constellation (NAVIC) was launched on January 20, 2016 aboard PSLV. IRNSS-1E positioned in 111.75° E longitude is providing its intended services along with other IRNSS satellites. IRNSS-1E successfully completes one year in orbit operations on January 20, 2017.

Felicitation to Prof. U.R.Rao

प्रो. यू.आर.राव को
'पद्मविभूषण' से सम्मानित किए जाने पर बधाई समारोह
FELICITATIONS
TO
Prof. U. R. RAO
On being conferred 'PADMA VIBHUSHAN'
10 मार्च 2017 /10 March 2017
इसरो उपग्रह केंद्र, बेंगलूरु / ISRO Satellite Centre, Bengaluru
AVF/ISAC

Republic Day Celebration

INSAT-3C – ON Orbit Mission Accomplished

INSAT-3C, a multi-band communication satellite, was launched on January 24, 2002 aboard ARIANE-4 (V147) Launch Vehicle. INSAT-3C has been providing Communication services in Nor C-band, Ext. C-band and S-Band frequencies to the nation from its orbital slot of 74^0 E longitude. INSAT-3C had successfully completed its design mission life of 12 years in 2014.

On Jaunary 24, 2017, the spacecraft successfully completed 15 years of in-orbit operations, three years more than the design mission life. The services provided so far by INSAT-3C have been migrated to other in orbit INSAT spacecrafts.

Editorial Message

The year 2017 began with the pleasant breaking news of Prof U R Rao, former Director, ISAC and former Chairman, ISRO, being honoured with the highest Padma award 'Padma Vibhushan'. The launch of 104 satellites in a single mission by PSLV-C37 is a significant milestone. Upagrah congratulate the team and appreciate the efforts. PSLV-C37 carried three of our spacecrafts: Cartosat 2 series satellite which has been now phased with Cartosat-2C already in orbit for best revisit capabilities providing submetre resolution imagery and realtime monitoring of site specific dynamics; and two nano satellites INS-1A & INS-1B which are less than 10 kg and have experimental payloads.

On the facility building front, the new year also saw many new inaugurations such as Biometric Access Control System, Dynamic Test Facility, Harness Lab, HDI Facility, etc.

This issue carries articles on how the mission life of MOM has been extended by some more years by changing the Sun elevation angle, a test system for OBC, ISRO health centre at Jeevanbimanagar, and, design & fabrication of RF components. Also events such as National Science Day, Women's Day, Swachh Bharat Campaign have been covered too.

For the first issue of Upagrah in the year 2017 we bring in a different look and feel for better readability. Our readers are encouraged to give their feedback on the changed design of the newsletter.

Dr. Anil Agarwal
Chairman, Upagrah Editorial Board

New Facilities Inaugurated by Chairman

Shri A S Kiran Kumar, Secretary, DOS/ Chairman, ISRO inaugurated the new facilities at ISRO Satellite Integration and Testing Establishment (ISITE) on 10th January 2017. In this event, chairman was accompanied by Dr. M Annadurai , Director, ISAC, and other officials and dignitaries from ISRO Satellite Centre (ISAC). The new world-class facility & comprises of Dynamic test facility, Harness Lab, Additional Cleanroom, vertically expanded Production building, Fire Station and the operationalization of High Density Interconnect (HDI) Facility. The Biometric based Access Control System at ISAC was also inaugurated by Chairman, ISRO on the same day.

The existing Production Building is a capital intensive facility for the fabrication and testing of Avionics Packages. The facility is extensively used by External vendors to realize subsystem package through various production mode. The vertical extension to existing production building was carried out to further augment the facility and aid in enhanced vendors' participation, off-the-shelf availability of subsystems packages, increasing the throughput capacity of the Centre.

The Dynamic test facility strategically located adjacent to the production building is equipped with 3.5 Ton shaker system along with corresponding vibration control systems to carry out vibration test on satellites subsystems/packages. The facility is planned to be augmented with a 6 Ton Shaker system to further aid in faster completion of subsystem level testing activities.

Inauguration of vertically expanded SEG production building at ISITE by Chairman, ISRO

Inauguration of Dynamic Test Facility at ISITE by Chairman, ISRO

Inauguration of Cleanroom at ISITE by Chairman, ISRO

Inauguration of Harness lab at ISITE by Chairman, ISRO

Chairman, ISRO at HDI Facility

Inauguration of Fire Station at ISITE by Chairman, ISRO

Additional 100,000 class clean room (conversion of existing harness lab) was established to undertake preliminary spacecraft Assembly, Integration and test activities. This additional cleanroom area will augment the satellite building capacity of the Centre. The new harness lab is planned to be equipped with all the tools and equipments for design, fabrication and testing of spacecraft harness. The facility will ensure that ready-to-assemble flight spacecraft harness is directly delivered to clean room for installation.

With the operationization of HDI Facility, it is now fully equipped to manufacture routine PCBs. Few dedicated equipments such as Laser Drilling, Direct imaging, Vertical electro-plating, Via Filling, Surface Planarizer, etc are planned to be established along with the other general state-of-the-art PCB equipments for realizing HDI PCBs.

A full-fledged Fire Station was established to safe guard valuable manpower & capital intensive facilities / equipments from fire incidents. The fire station houses a Fire Control room, Fire alarm system Monitoring Room, Appliance room, Maintenance room, Store room for Personnel Protective equipment and fire fighting equipments and training hall.

With the establishment of these state of art facilities, ISAC has taken the winning steps towards making ISITE a nodal hub for satellite production activities. With this, ISITE, established under the aegis of ISAC is one among very few in the world that houses state-of-the-art facilities from PCB fabrication to the assembly and Integration of the Satellites along with the Regional Remote Sensing Centre for various Satellite applications.

As part of enhancing ISAC and ISITE security, finger print based Biometric based Access Control System was established in the two campuses.

Inauguration of Biometric Access Control System by Chairman, ISRO

CARTOSAT-2 SERIES SPACECRAFT

Sri. D. Sadananda Rao
Project Director

The fifth spacecraft under Cartosat-2 series was launched by India's Thirty Ninth flight PSLV-C37 with 103 Co-Passenger Satellites. Cartosat-2 series was the primary satellite carried by PSLV-C37.

Cartosat-2 series satellite is similar to Cartosat-2C with panchromatic camera and a 4-Band Multispectral camera operated in *'Time Delay Integration (TDI)'* mode. It provides scene specific imageries of 0.64 m spatial resolution in panchromatic camera and better than 2 m in multispectral camera with a swath of 10 km. This three-axis stabilized mission provides spot images of the desired location and has the capability of along track steering to provide stereo spot imageries and across track steering upto $\pm 26^0$ to enhance the range of spot imageries. Cartosat-2 series also carries two Event Monitoring Cameras Ev1 (0.5 m Monochrome) and Ev2 (0.4 m RGB) to provide video imagery of pre-selected site with sub meter sampling to build the capability for real time monitoring of ground events. The wet mass of the satellite is around 714 kg with propellant mass of 75 kg and the power generation capability is around 986 W at beginning of Life.

The imagery sent by the satellite will be useful for cartographic applications, urban and rural applications, coastal land use and regulation, utility management like road network monitoring, water distribution, creation of land use maps, change detection to bring out geographical and manmade features and various other Land Information System and Geographical Information System applications.

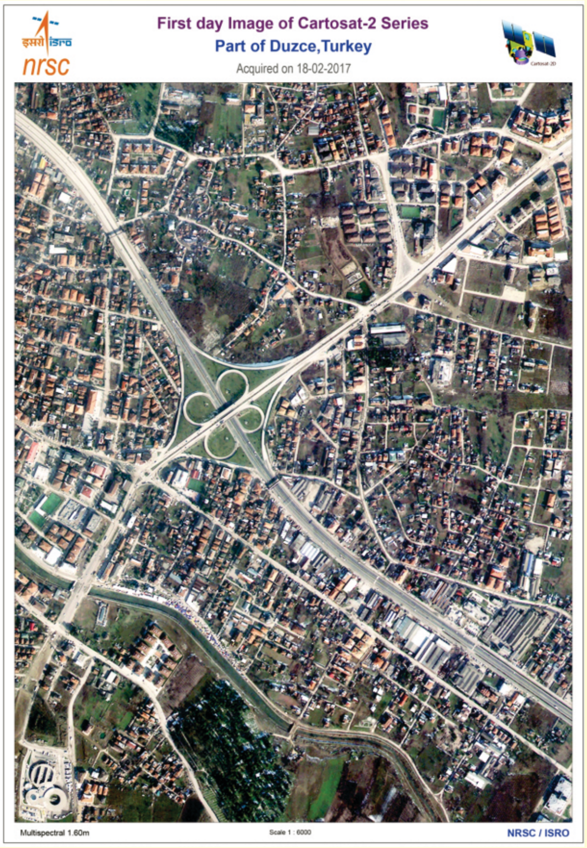
The spacecraft's nominal altitude is 505 km. The Cartosat-2 series is phased with Cartosat-2C and the constellation of these two satellite will provide 3 day revisit capability. In view of 103 co-passengers, Cartosat-2 series with all the co-passengers was injected into a mean orbit of 500 km and orbit maneuvers were done using spacecraft reaction control system to get the intended orbit and phasing.

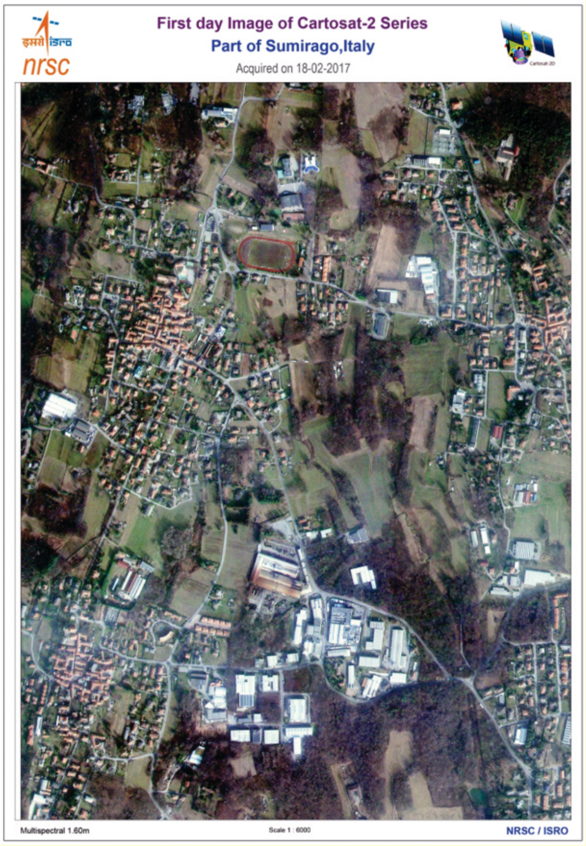
The RCS system includes heritage surface tension type propellant tanks of 35 liter capacity, eight 1N thrusters canted by 30° inwards towards negative yaw axis and four non-canted 1N thrusters. *For the first time one block of non-canted thrusters is configured with indigenous thruster bed heaters developed by LPSC (B).*

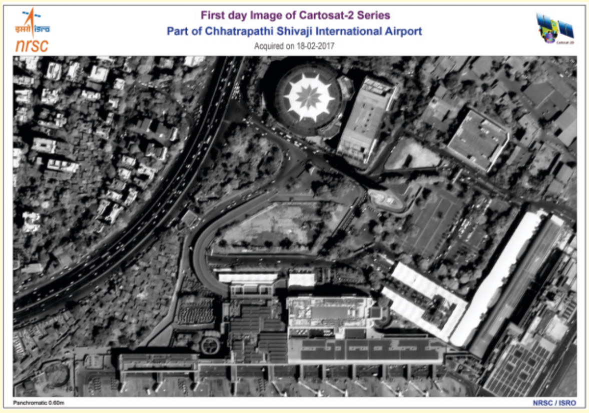
Similar to other Cartosat Satellites, Inertial reference unit (IRU) and all Mark-II Star sensors are used as attitude sensors. Star sensors are operated in dual head mode of operation for location and target accuracy improvement. *The structure for the telescope of this spacecraft has been built with indigenously designed and qualified composite structure* by CMSE. The on-orbit performance of the structure has been validated for functional performance. Focal plane uses split field configuration based on field separation by using multiple fold mirrors for optical butting of PAN and MX detectors. High resolution PAN and Multi-spectral camera along with the camera electronics and Two experimental "event monitor" (EvM) cameras can operate in different modes to meet the imaging and calibration requirements.

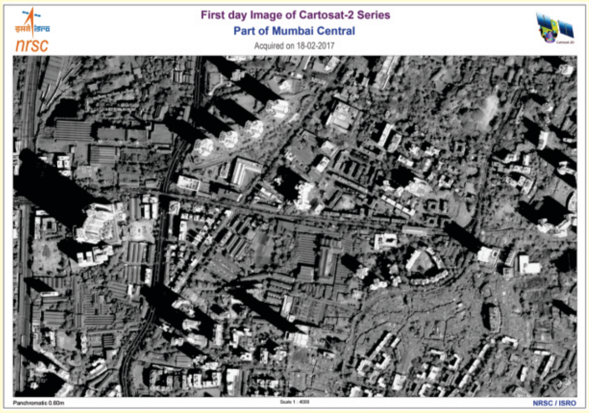
Many new technologies like TDI operation of detectors, AOS commanding, Macro mode of operations, LP sequencing, Eclipse drag mode, DWT based compression, Sliding redundancy of DH systems, Fusion mode of star sensor operations, Payload modes, have gone through performance validation during IOT phase of Cartosat-2C and Cartosat-2D is also configured with all these new features. An In-house designed 12 Channel SPS system which is a new development, is also flown in Cartosat-2 series.

Cartoast-2 series spacecraft is currently delivering quality imageries as shown below in Panchromatic and Multispectral bands similar to Cartosat-2C.


First day Image of Cartosat-2 Series
Part of Duzce,Turkey
Acquired on 18-02-2017


First day Image of Cartosat-2 Series
Part of Sumirago,Italy
Acquired on 18-02-2017


First day Image of Cartosat-2 Series
Part of Chhatrapathi Shivaji International Airport
Acquired on 18-02-2017


First day Image of Cartosat-2 Series
Part of Mumbai Central
Acquired on 18-02-2017

ISRS –BANGALORE CHAPTER

IRS-1A Launch Anniversary Commemoration Function

IRS-1A, the first operational Remote Sensing Satellite was launched by ISRO on March 17, 1988. It has been one of the milestone achievements in the history of ISRO.

A function to commemorate the launch anniversary of IRS-1A Spacecraft was organized by ISRS - Bangalore Chapter on March 17, 2017 at Satish Dhawan Auditorium, ISAC. Dr. M. Annadurai, Director, ISAC and Chairman, ISRS - Bangalore Chapter graced the occasion. Chapter members and ISACians thronged the Auditorium with an eagerness to witness the proceedings.

Dr. G.Nagesh, Programme Director, IRS & SSS and Vice-Chairman, ISRS - Bangalore Chapter welcomed the audience. Two invited lectures were delivered by Shri V.Bhanumurthy, Associate Director, NRSC on the topic 'Geospatial Technologies for Disaster Management' and Dr.S.N.Omkar, Chief Research Scientist, Aerospace Dept, IISC on the topic 'Satellite Image Classification and Applications'. The event concluded with Shri S.A.Kannan, Secretary of the Chapter, proposing a vote of thanks.

SAVING MOM FROM THE LONG SHADOWS OF MARS

The Long Eclipse Avoidance Maneuver performed on 17th January , 2017 at 15:01 UT was one of the most critical and life-saving maneuvers for the Mars Orbiter Mission. The orbit before the maneuver was 500 km X 71050 km with the orbital period of 65.3 hrs. For such an orbit, the Sun and Satellite geometry on Jan 28, 2017 would have been such that the Sun would cross the perigee and the orbital plane simultaneously giving rise to six occurrences of long eclipse with duration ranging from 5 hrs to 8 hrs while the satellite design is tuned to experience the maximum duration of 100 mins only. As per thermal analysis, if the heaters are switched off, the plumb lines will reach the temperature of -15°C in 40 mins and the battery reaches 0°C in 2.5 hrs which would make it impossible for the satellite to survive the long duration eclipse and hence the maneuver was very essential to ensure that the total eclipse duration to be always less than 100 mins.

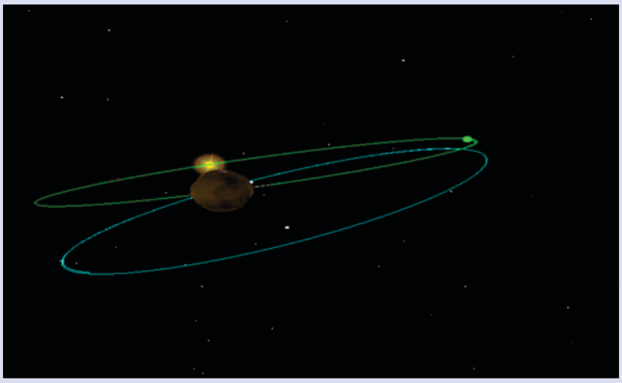


Fig-1:Orbit Plane Change To Avoid Long Eclipse
Blue : Old Plane Green : New Plane

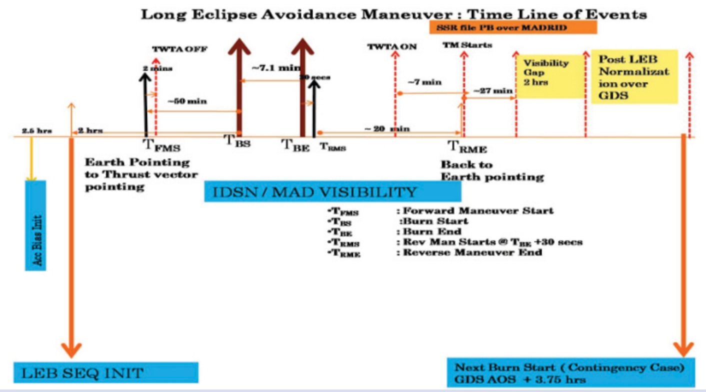

Long Eclipse Avoidance Maneuver : Time Line of Events
SSR file PB over MADRID
TWTA OFF
2 mins
~7.1 min
30 secs
~50 min
TWTA ON
TM Starts
~7 min
~27 min
Visibility Gap 2 hrs
Post LEB Normalization over GDS
2.5 hrs
2 hrs
~ 20 min
T_{FMS}
T_{BS}
T_{BE}
T_{RMS}
T_{RME}
Earth Pointing to Thrust vector pointing
Back to Earth pointing
IDSN / MAD VISIBILITY
Acc Bias Init
•T_{FMS} : Forward Maneuver Start
•T_{BS} :Burn Start
•T_{BE} : Burn End
•T_{RMS} : Rev Man Starts @ T_{BE} +30 secs
•T_{RME} : Reverse Maneuver End
LEB SEQ INIT
Next Burn Start (Contingency Case) GDS AOS + 3.75 hrs

Fig-2: Timeline events on Jan 17, 2017

The out-of-plane maneuver strategy was planned to sufficiently increase the Sun elevation with orbit plane when Sun is crossing periapsis direction in Jan 2017, so that the orbital path totally moves out of the shadow region. The main advantage of this strategy is that this brings down the eclipse duration to below 100 min for the next four years, i.e., up to end of 2020. This maneuver mainly changes the ascending node and argument of perigee along with a relatively smaller change in inclination . It is optimal to perform the maneuver before start of the first eclipse occurrence of the season, with the maneuver point occurring about 29 hours before eclipse start, i.e., on Jan 20, 2017 but entire planned delta-V has to be imparted in one operation, which makes it a very critical operation. Due to its criticality, this operation was planned one orbit earlier i.e. on Jan 17, 2017. If the maneuver gets aborted, for any reason, then the remaining delta-V had to be imparted within next couple of hours.

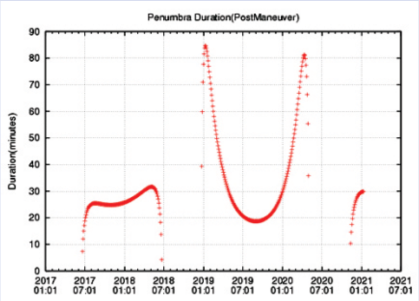


Fig-3: Eclipse profile using post maneuver OD

The total maneuver was executed using the LEB Sequencer in Back-up Mode (i.e. using 22-N thrusters only) with full autonomy. Total sequence was loaded 5 days prior to actual operation i.e. on Jan 12, 2017 with all verifications . The total time-line of operation on Jan 17, 2017 is given in Fig-2. As the antenna was not pointing the Earth, the complete operation was performed by onboard sequencer without any ground intervention.

As seen from Fig-3 above, the total eclipse duration is within 85 mins till 2021. The remaining propellant is around 13 kg. With the execution of this critical maneuver, life of MOM is extended successfully.
LONG LIVE MOM !!!!!!!!!!!!

TEAM MOM

RF Passive Components Design, Fabrication and Realisation
Spacecraft Checkout Group

Spacecraft Checkout Group (SCG) evaluates functional performance of the Spacecraft during various phases, keeping SCG Quality policy of being committed to Total Quality in Spacecraft Checkout Systems and Spacecraft Checkout Operations. In addition SCG has adopted SCG quality policies:

- Timely delivery of Reliable Spacecraft Checkout Systems.
- Precise Characterisation of Spacecraft Systems in all possible Configurations during all phases of Spacecraft tests, at various stages of assembly before Launch.
- Achieving Zero Mistakes during Spacecraft Checkout operations.

For realising Spacecraft Checkout Systems for the above purpose, the group has to develop various Simulation units, Down Converters, Up Convertors, Transmitters, Demodulators, Receivers, Switch Matrix etc. Checkout Group has initiated development of the passive Components which are required for realising most of the above Systems.

For Payload testing, SCG needs many RF passive Components like Filters, Power Dividers, Waveguide Couplers etc. These Components either have to be procured or developed in-house.

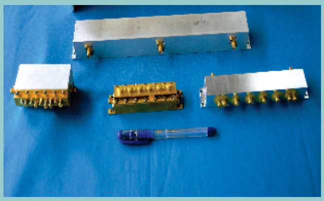
There are many challenges in procuring these components, some of them are listed below:

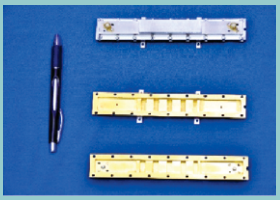
- Stringent Specification - Limited Vendors only are available
- Quantity Requirement - As the quantity is very less, no Vendors will be willing to supply readily.
- Turnaround Time - These Components are required in very less time, to realize the project and it is not possible to procure the same, within the project schedule.
- Flexibility in Specifications - Last Minute changes in Specification cannot be accommodated if it is procured.
- Expensive & involves Foreign Exchange (FE) - Components are very expensive due to requirements of Skilled Man Power, State of Art Design & Fabrication facility and involves Huge FE.
- Test & Qualification - The Vendor supplies the Components as per design without High Power testing, so in-house acceptance for High Power has to be carried out, adding time delay.

In order to overcome the above difficulties, many steps are taken for design, development, fabrication, test & qualification of components, which saves considerable time & money and gives flexibility in design & adaptability to various projects. One of the major motivations for In-house development is cost saving and less turnaround time. For example: One S-band Pressure Window developed in-house costs Rs.0.30 L and procuring from outside will costs Rs. 3.0 L (Ratio 1:10). Similar cost difference exists for all other components. Thus developing these components in-house not only gives advantages of saving turnaround time but also saves crores of rupees each year.

Following is the glimpse of the products which are designed, developed, realized and being currently used for many spacecraft payload testing which has resulted in savings of crores of rupees to the organisation.

Ka Band Fin line Band pass filter

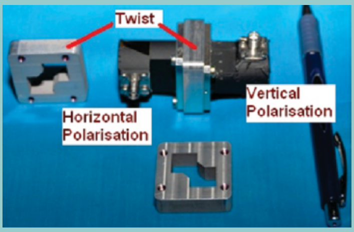

Diplexer and Band Pass Filters

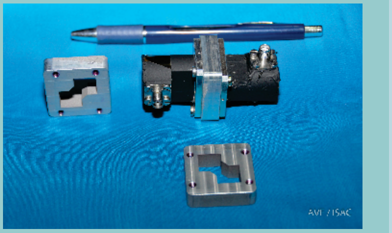

Ku band Harmonics rejection filter

A) Filters and Diplexers : To meet the requirements of project, many Filters and Diplexers are designed which are Frequency Band and Frequency Specific with advanced design having very low Insertion Loss, Low Ripple and Good Roll off. These are realised across Frequency Bands and are compact in size to meet the miniaturization requirements and are used in Checkout Equipments.

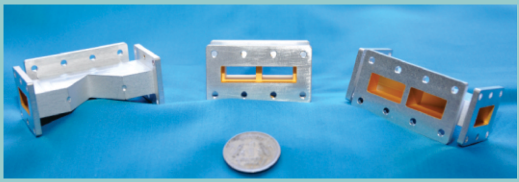
B) Waveguide Components : For characterisation of High Power Transponders, Waveguide schemes are preferred and implemented as conventional Co-axial cables cannot handle higher powers (greater than about 100 W) and also the losses of cables are high especially at higher frequencies. So Waveguides has to be routed from Spacecraft to Checkout System, and this Waveguide routing may require E-plane and H plane

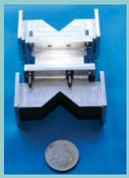
Bends, Waveguide Twists, Waveguide Couplers, Power Dividers, Waveguides Transformers, etc. Checkout Group has taken more initiative for developing and delivering all these Components in time.





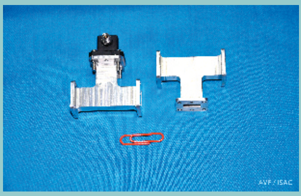
- **Waveguide Twist :** Checkout Group developed new compact (10 mm length) Ku-Band Waveguide Twist for changing the direction of polarisation, i.e., horizontal to vertical or vice versa for GSAT-11 applications. This newly developed twist is very compact (10 mm length compared to conventional 100 mm length) & gives broadband performance.



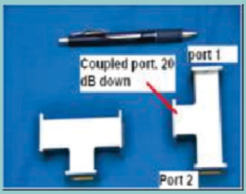


- **Waveguide Couplers:** While testing of spacecraft the output is sampled through a coupler and the Coupled signal is taken to Checkout System for further processing. Checkout Group developed Ku-Band compact 20 dB coupler with better than 20 dB directivity for GSAT-11 Checkout applications with low insertion loss and high power handling capacity. This activity was initiated as the coupler with this specification was not available commercially and even if available would have taken enormous time and money for procurement.

- **Waveguide unequal Power Dividers:** Waveguide 4-port Couplers can be replaced with 3-port unequal Power Dividers, which give same sampled output as 4-port Couplers. This unequal Power Divider is simple, compact and avoids extra match load requirement. Ka-Band 10 dB Power Divider and Ku-band 20 dB Power Dividers have been developed for GSAT-11 Checkout applications.

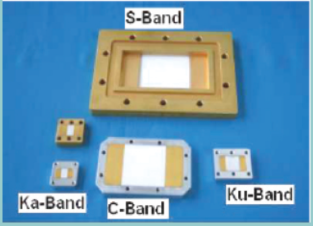


Ka-band 10 dB power divider

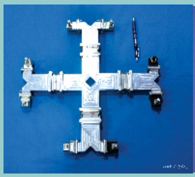


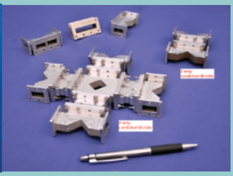
Ku band 20 dB power divider

- **Waveguide Pressure Windows :** To isolate satellite from ground conditions during Thermo-Vacuum tests, Waveguide Pressure Windows are required. Pressure Window is a slab of dielectric (alumina substrate) attached to a metallic flange. It is used at the interface of thermo-vacuum chamber for isolating vacuum and ambient conditions existing on either side of the chamber. It is electrically transparent for a Microwave Transmission and mechanically maintains the pressure difference.

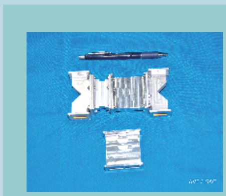


Checkout Group took effort to realise this Pressure Windows at various Frequencies, S, C, Ku, and Ka-band. All these Windows have High Power Handling Capacity (Approx 2 kW) and are able to withstand High Atmospheric Pressure difference (of the order of 5-6 atmospheric pressure) with leak rate better than 10^{-9} std.cc/sec (Helium).All these Windows are used for testing various Spacecrafts like, starting from INSAT -4B onwards to the latest MOM, GSAT-4, GSAT and IRNSS series.

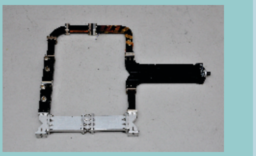




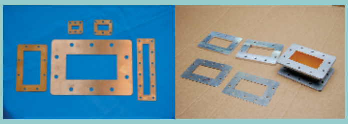
- **4-way Power Combiner :** GSAT-11 Spacecraft has adapted new technology with Multi-Port-Amplifier (MPA). For testing MPA, Checkout has come out with new concept of 4-way Power Combiner/ Frequency - Combiner at Ku-Band Frequency. This Power/ Frequency-Combiner is able to handle High Power of the order of 1 kW, with 6 dB power division over 1 GHz Bandwidth. It is actually 8-port device with 4 inputs and 4 output, the output is terminated with 200 W Thermo vacuum compatible loads. The advantage of this concept is that the Low Power TVAC compatible Loads can be used even while channelizing higher power into any one output port.



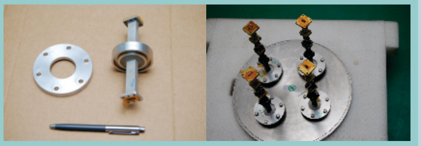
- **Power Combiner :** All the RF Components have to undergo High Power Test before they are deployed for Spacecraft testing. Checkout Group developed Waveguide Ku-Band Power Combiner-for High Power activities, which is used for combining same frequency from two high power TWTAs. This Power Combiner is simple, compact and can replace traditionally used multiplexer for High Power testing and qualification of Waveguide Components. This Frequency Combiner has been developed using 3-dB hybrid and 90 degree differential phase shifter.



- **Ring Resonator:** Most of the Waveguide Components like Waveguides, Pressure Windows and Couplers etc have to be tested and qualified for High RF Power with 3 dB higher margins before the use of these Components. By using High Power TWTA or combining the Low Power TWTA, this can be achieved, but that requires that very Complex Test Setup, Time, Cost and more man power. Checkout Group developed Ring Resonator, a simple set up with 6 dB Gain using 3 dB hybrid coupler, which in turn replaces 4 High power TWTAs to generate 2 kW.



- **Waveguide Shims :** While testing Spacecraft during IST/TVAC conditions, Waveguide has to be routed from Spacecraft to Checkout equipments. This Waveguide routing is done using Waveguides of various lengths, Flexible Waveguides, E and H bends, Twists etc. RF leakages at the Waveguide joints can be arrested /minimised using proper Shims. Checkout took initiative to develop, indigenise and realized required Shims of various Waveguide types and successfully used for all Waveguide Routing during Spacecraft testing.



- **Feed Through's :** While testing Spacecraft or Waveguide Components under TVAC conditions, Differential Pressure has to be maintained, which can be achieved using Feed Through's integrated with Pressure Windows. Universal Feed Through's were designed, developed and realized across all Frequency Bands. These Feed Through's facilitates easy mechanical assembly with proper alignment for different types of TVAC flange catering to all types of Chambers for Components and Spacecraft testing within a short time. This feed through assembly has been used for testing from INSAT-4C onwards with latest in GSAT-4, GSAT and IRNSS series.

Spacecraft Checkout Group acknowledges contributions from Large Space Simulation Chamber Facility (ETF-II); Hybrid Micro circuits Division; Planning and External Fabrication Facility; Precision Fabrication Facility, ISAC

Spacecraft Checkout Group

GEM Awareness and Training Program

An awareness and training program on Government e-Market Place (GEM) was held on **February 23, 2017 at 13.30 Hrs in Satish Dhawan Auditorium**. Shri H. R. Sharma, Deputy Director General (DDGQA), from Hyderabad conducted this program. About 150 ISACians attended the program. The program was quite informative and had a very lively interaction between the speaker and the audience. A brief about GEM is as follows:

GEM is hosted by DGS&D where common user goods and services can be procured. GEM is dynamic, self sustaining and user friendly portal for making procurement by Government officers. Authorised representatives of Central Government Departments/ State Governments/ PSUs/ Autonomous bodies can utilize the GEM. The main features of GEM are as follows:

- Listing of products for individual, prescribed categories of Goods/ Services of common use.
- Look, estimate, compare and buying facility on dynamic pricing basis.
- Market place buying of majority of common User Items.
- Buying Goods and Services online, as and when required.
- Single window system for aggregating demands and ordering.
- Transparency and ease of buying.
- Useful for low value buying and also for bulk buying at competitive price using Reverse Auction/ e-bidding.
- Continuous vendor rating system.
- User friendly dash board for buying and monitoring supplies and payments.
- Return policy.

SMALL SATELLITE OBC TEST SYSTEM

Onboard computer (OBC) realizes the functions of Command processing, Data acquisition and processing, Attitude and Orbit control, Telemetry (TM) and Housekeeping (HK) and Thermal Management of the spacecraft and uses standard interfaces as well as MIL-STD-1553B with rest of the spacecraft. OBC has interface with Power System, Sensor System, Inertial System, Thermal System, RF System, Actuators, Propulsion Systems, and Mechanism. Testing is essential to avoid incompabilities before the system integration. Test system plays a vital role in the testing of the OBC. All interfaces of OBC with the rest of the spacecraft have to be simulated in the test system. Harness also gets simulated in the test system. Test system has to support IBT/ Vibration/ Thermovac/ FBT phases of the OBC. It has to be rugged and robust. Major units of test system are explained in the following section.

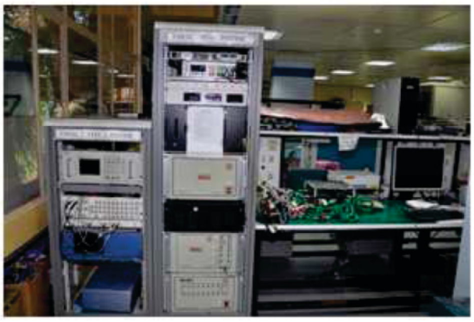


Figure 1: SARAL/Scatsat test system

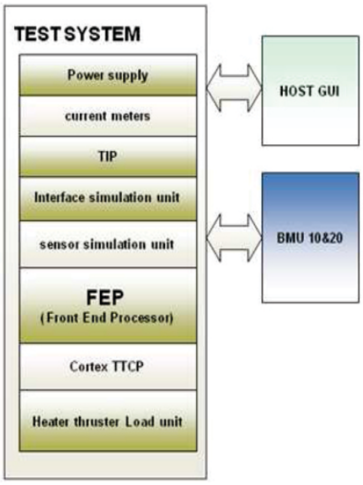


Figure2: Test system Block diagram

- **HOST Computer:**

It mainly consists of Tele Command, Telemetry processing and Graphical User Interface modules, data archiving and retrieval modules. The different processes in HOST architecture are depicted in figure 3. Simulation software resides here. Models for various sensors run at the Host. Spacecraft dynamics will be running on this computer. This is required for all the closed loop simulations. In closed loop simulation, based on spacecraft dynamics and actuator excitation, sensor inputs are varied and fed back to the OBC. Accordingly it will have orbit model, sun model, earth model etc. Typical closed loop simulation sequence is provided in figure 4.

The configuration of any spacecraft is a closed loop system where the error data is received from the sensors, the Onboard Attitude and Orbit Control Systems (AOCS) processes the error, generates the correction data and operates the actuators to keep the spacecraft in the desired orientation. Role of sensor and actuator will be played by test system with this HOST computer for the closed loop simulation test of OBC. The simulation is initiated with an initial reference ie the initial orientation of the spacecraft which is user defined. The actuators thruster and wheels provide the torque for changing the attitude of the spacecraft. Thrusters mainly used for attitude, orbit control operations operate in PWPFM mode and produce thrust. The thrust pulses generated by OBC are captured by the test system and are used to calculate the thrust generated on each axis of the spacecraft. Similarly the torque pulse generated by the AOCS for the wheels are also captured by the test system and fed to the dynamic model running in the HOST. Based on these inputs the dynamic model computes the body attitude (quaternions qib) and body rates (wx,wy,wz). This data is fed to sensor models which compute the error with respect to the reference attitude .

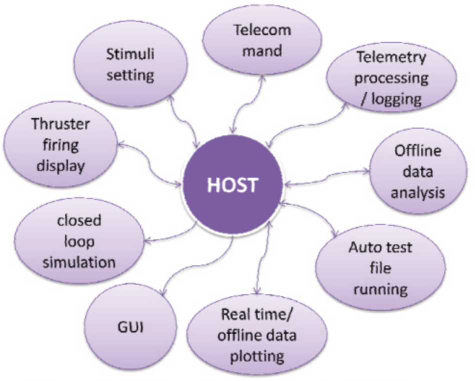


Figure 3: Different processes in HOST

Apart from this closed loop simulations, HOST PC has the database for telemetry and telecommand. It has a Graphical User Interface (GUI) which enables to test OBC through a set of test files. These test files aid auto testing of OBC. Real time/Offline telemetry plotting is also available. TM Data logging is provided for offline data analysis. Offline data analysis tools are also available in the HOST.

✪ FEP (Front End Processor):

Data acquisition software resides in a Front End Processor. Interface modules and device drivers are hosted at FEPs (Front End Processors) for sensors and actuators simulations. FEPs are typically Industrial PCs. Host and FEP work in a client/server configuration. FEP software has a critical role to play in ensuring the deterministic performance of closed loop simulations. Major components of FEP are software scheduler, TM thread and TC thread. Scheduler runs every 1 ms, invoked by a hardware interrupt. TC thread and TM thread are in turn scheduled by the scheduler. TC thread receives output data from SModel and sends them to OBC. It also collects actuator commands from OBC and sends them to SModel. TM thread collects FEP HK data and sends them to host.

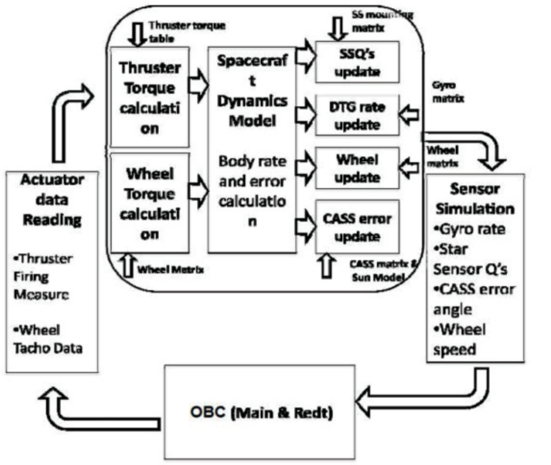


Figure 4: Closed loop simulation

FEP contains the PC Add-on cards to simulate the digital signals. It contains Xilinx sparton-3 based PCI card to simulate the digital interfaces like RMU / 8bit Digital TM/ wheel speed/ torquer reading etc. It also consists of PC Add-on Card for digital to analog conversion to simulate analog sensors. Apart from the hardware it has software which runs in near real time to interact with these cards. It communicates with the host software through socket connection. 1553 interface simulation board is also housed in this FEP. Bus Monitor for 1553 data bus analysis is also provided in FEP. 1553 application carries out various RT simulations as per the requirement. Typical FEP architecture is provided in figure 5.

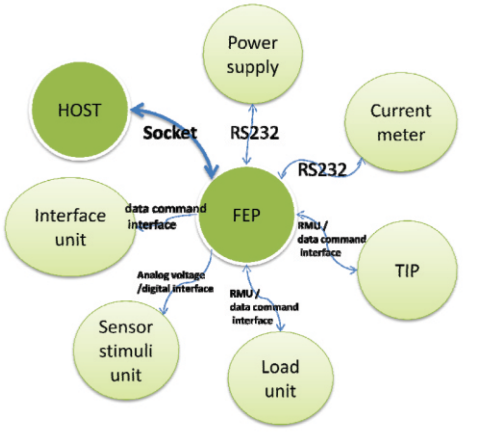


Figure5: FEP interface details

SARAL/SCATSAT had CCSDS based TM and TC. Hence Cortex telemetry telecommand processor (TTCP) is used to receive the telemetry data and command the OBC. Cortex TTCP communicates with the HOST through socket communication. Provisions are made in HOST to command OBC in all the modes like AD/BD/BC.

The other units are power supply unit which simulates Raw Bus (RB) and UB of spacecraft. Sensor Stimuli unit is used to simulate the sensors like Coarse Analog Sun Sensor (CASS), SPSS, PRT, Fine temperature Sensor (FTS), Thermocouple, 4PI, magnetometer etc. Each sensor will have an interface circuit similar to the actual hardware. Interface Unit which provides stimuli for various interfaces like analog channels, thermistors, digital bits monitoring, differential signal receiving, RF bits of various subsystems. Resistive loads are used to simulate actual load in terms of current drawn for heaters and thrusters. Based on heater capacity resistive loads are provided to each heater interface. Heater on/off are monitored and thruster duty cycles are computed based on the actual firing.

All the commands from OBC package are monitored with the help of Telecommand interface package (TIP). It receives all types of commands (such as pulse/ level/ RB pulse/ EED/ data command) commands from OBC and provides the status to the HOST computer through FEP.

Harness plays an important role. Harness between the various stimuli units and OBC will be equivalent to the spacecraft harness.

IMS-1 series test systems have been realised with the help of vendors. In IMS-2 series, Sensor stimuli, Interface Unit, Heater load units are realised with vendor support and test systems are realised here.

Conclusion: Test systems are an integral part of testing. In an integrated environment of the spacecraft we may not be able to test all the cases. But at the subsystem end with the help of test system, complete testing is possible. It enhances the confidence in hardware and integrated testing. For the more meaningful testing, test system has to be more reliable than the onboard. Each and every part of the test system has to be more reliable and accurate. It should not cause any damage to the package. Hence quality and reliability should be doubly ensured at the ground system end . All these have been achieved with small satellite OBC test system described above. This test system provides a test bed for the rigorous testing of flight software and hardware of OBC. It has the necessary simulations for the logical and design test of the small satellite OBC. It facilitates the exhaustive and rigorous testing of attitude and dynamic control algorithms. This test system has been employeed to successfully test SARAL /SACTSAT OBC's.

Test System Development Division, CDEG

Best Paper Presenter Award 2016

Dr Kamaljeet Singh a senior Engineer of SEG/SPA, has received "Best Paper Presenter Award 2016" at International Conference on Interdisciplinary Research for Sustainable Development (IRSD-2016), NITTR, Chandigarh along with "Outstanding Researcher award for his contribution in the field of Space and Microelectronics". He was also declared best presenter at NCRDE conference 2017, held by IEEE-EDS at Delhi University.

Limaye best paper award

A Paper titled " Spacecraft Level UnFurlable Antenna Characterization in CATF", presented by Shri. Puneet Kumar Mishra, in International Symposium on Microwaves , ISM-2016, held at Bangalore during Dec 21-22 , 2016, bagged the Limaye best paper award. The authors of the paper are Puneet Kumar Mishra, Satish Kumar Bandlamudi, Purushothaman S., Sasikant Kumar, Haindavi Maligilla, Renuka R., S S Kumar, and Dr. V K Hariharan, ISAC.

Annual Service Excellence Award for the year 2015

Smt Uneza Parveen
Project Personal Secretary

Shri Saravanan V
Purchase & Stores Officer

Smt S V Asha
Sr. Project Asst.

Smt L Uma devi
Personal Secretary

Smt M Nirmala
Personal secretary

Shri Ramesh S V
Sr.Project Asst.

Shri Shivaprakashan M A
Project Personal Secretary

Shri Narayana M P
Cook

Shri Antony S
Cook

Shri Ramaprasad Rao A
Accounts Officer (Retired)

Nari Shakthi Award

Ms. Anatta Sonney, Orbit Dynamics Division, Flight Dynamics Group is awarded with Nari Shakti Puraskar, 2016, by Ministry of Women and Child Development Department, Government of India, jointly with another two lady scientists from VSSC and SHAR. The award was presented by the honorable President of India, on March 8, 2017 at Rashtrapathi Bhavan, New Delhi. The award carries a certificate and a cash prize of Rupees One Lakh (jointly).

ISRO HEALTH CENTRE

ISRO Health Centre, popularly known as 'Bima Nagar dispensary' is the main departmental health centre under CHSS scheme in Bengaluru. It is the busiest centre among all the health units in Bengaluru serving around 1800 primary beneficiaries who are attached & many others coming from various parts of Bengaluru and surrounding areas. Apart from employees & pensioners of DOS and DAE, health centre also lends services to CISF personnel and their family. Contract employees working in ISAC/LPSC also avail emergency treatment.

Akin to ISAC, Health centre also had a very humble beginning in sheds of Peenya in the year 1972, it started with one unit in sheds of Peenya and the other at Rajajinagar Guesthouse. Later in the year 1978, it shifted to Jeevan Bima Nagar. A Medical unit inside ISAC was started next to workshop in the main building. Residential quarters were converted into JB Nagar dispensary and this facility served for 33 yrs. Present building with 3 floors was inaugurated in Dec 22, 2011.

ISRO Health Centre can be called a complete Primary Care Centre. The Health Centre works from 8 AM-8 PM on Monday to Friday and on Saturdays up to 5pm. Presently we have 5 departmental doctors including CMO and 2 doctors on contract. Every day around 200 patients visit the centre. All age group patients are taking treatment here. Apart from treatment preventive advises, health checks, camps and health talks are arranged regularly. The Health Centre is co-ordinating in conducting mandatory biennial health check of employees, CISF SHAPE examination and annual health check up for employees working in hazardous areas at LPSC. Usage of Arogya software (details in separate write up) has made the work paperless.

Facilities available at ISRO Health Centre

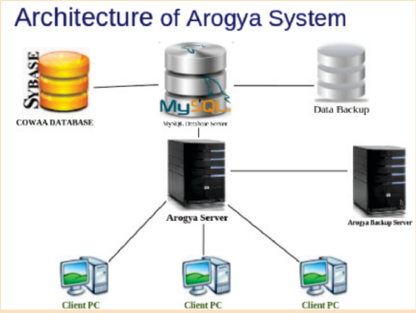
Pharmacy	Drugs for acute and chronic diseases. Over 200 brands are available.
Laboratory	Haematology, Biochemistry, Special tests- Thyroid profile, HBA1C, Microbiology, Urine routine test, Stool test,
Emergency treatment room facilities	7 beds available for patients who require day-care. Emergency equipments like Cardiac defibrillator, Cardiac monitor, Nebulizers, Oxygen cylinder, ECG Machines, Pulse oxymeter are available for patients use. Emergency drugs administration IV infusions, Vaccinations, regular injections, suturing, abscess drainage, regular wound care are being done.
Radiology	Digital X-Ray, Ultrasound/ECHO machine
Physiotherapy	USG, IFT, SWD, Wax baths, Nerve stimulator, Traction, exercise equipments, Shoulder wheel

Staff pattern

Doctors	7
Nurses	7
Pharmacists	4
Physiotherapist	2
Lab Technicians	3
X -ray Technicians	2
Medical attendants	2

Dr Aravinda Kumar M, Deputy Head, Medical

Arogya Software



The Arogya Software is being used at ISAC dispensary. This software provides various modules for Doctors, Pharmacy, Laboratory, Nursing and Registration. The Doctors module is used by the doctors in their consulting rooms for recording diagnosis, prescription, viewing laboratory data and patient's previous history during the course of their daily work. The software is also advantageous for the doctors in issuing repeat medicines and medical/fitness certificates. The Pharmacy module is used in the ISAC pharmacy for managing dispensing medicines prescribed for the patients by Doctors daily. The nursing module is used in the nursing room for dispensing injectable medicines to the patients. The Laboratory module is used by clinical laboratory for performing various laboratory tests prescribed for the employees, pensioners and their dependants and to generate laboratory test reports of the various laboratory tests done in the ISAC health centre.

The usage of the software provides seamless access to patient medical data like medicine or stock availability and medical history which will aid in faster decision making for doctors and management. The software has been extensively used in ISAC dispensary for the past 6 years. Computer and Information Group (CIG) are providing technical support for software customization and maintenance. A copy of this software has also been handed over to VSSC software team. The usage of Arogya Software is shown in Fig. 2.

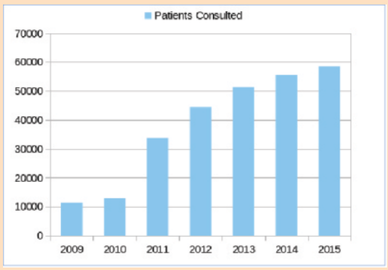


Fig. 2: Arogya Software Usage

Pratap K M , Yogeen Sadananda Honnavar, Rakesh Kumar, CIG

INTERNATIONAL WOMEN'S DAY 2017 AT ISAC

The International Women's Day was celebrated on March 7, 2017 at ISAC. It started off with an inaugural ceremony in the morning and the celebrations went up till 4.30 pm in the evening. Ms. Vaishali Kasture, Partner, Deloitte India, a celebrated Marathon Runner who has participated in several ultra-marathons across the Globe was invited as the chief guest for the event. Dr.Rajalekshmi, Founder of Srishti Life – an NGO which deals with child sex abuse was the Guest of Honour. She is also a gynaecologist by profession. The inaugural session started with address by Smt. Nigar Shaji, Chairperson, IWD organising committee and went on with talks by both the guests. A souvenir was released with articles from women employees of ISAC and LEOS by Director, Dr. M Annadurai, Ms.Vaishali and Dr.Rajalekshmi.

The IWD report was presented in which a video on school visit held by the organising committee members was showcased. The school visit was organised as part of social responsibility activity for IWD-2017. It was conducted on February 23, 2017 at 'Vivekananda Vidhyasala', a semi government school with a talk and quiz programme for the high school students. Gift packets with stationery set were distributed to all students who took part in the function.

The afternoon session had a workshop by Ms. Seema Raghunath on continual pursuit of career progression for women titled – "The GREY TWEED JACKET". The celebrations concluded with cultural programmes by employees of ISAC.

IWD Team

International Women's Day

GLIMPSES OF SWACCH BHARATH TEAM VISIT TO GOVT. PRIMARY AND HIGH SCHOOL, MARALAKUNTE ON 13 JAN 2017

Maralakunte, is a small town between Nelamangala and Tumkur, 8 km away from the Main road. Nearly 250 children study in both Primary and High school put together. Dr. Girish spoke to the children about the importance of cleanliness- at home, at school, in the town. He also explained why we should avoid the use of plastic and how we can recycle and reuse the waste we generate. Dr.Aravind re-emphasised the role of personal hygiene in an interactive session with children.

Topic of essay was “Swachh Bharath Abhiyaanadalli Shaalaa MakkaLa Javaabdaari (Role of School Children in Swachh Bharath Abhiyaana)”. Exciting prizes and certificates were given away in a valedictory function. Dr. Girish and Nagendra conducted a lively quiz on space, ISRO, sports and general knowledge. Dustbins donated to keep school litter free – saplings given to make school campus green. Easy to read kannada books written by ISRO authors donated to school library. Returned to ISAC after sumptious lunch at school –touched by the warmth and hospitality of the small town folk.

Visit to govt school at Maralakunte

GLIMPSES OF SWACCH BHARATH TEAM VISIT TO GOVT. HIGHER PRIMARY SCHOOL, MUTHURAYANAGAR, ON 22 FEB 2017

Shri V.Chandra Babu gave an introduction to the staff and students on Swacch Bharath Abhiyaan and the purpose of our visit. Dr.Radhakrishna spoke to the children (around 120) on cleanliness - starting from self, going on to home, next, keeping the school, town, city and finally our country clean. He touched on waste seggregation, wet and dry wastes to be collected separately at home, introduced the concept of reduce, re-use and re-cycle and why we should avoid the use of plastic. Dr. Nagendra reminded children of cleanliness of mind was equally important for a clean India – no lying, no cheating, no copying during exams. Topic of the essay competition was “Swacch Bharath”. Children wrote on how they could contribute to this mission. For younger students, we had a drawing competition on “keeping my school clean” .

Children were given a talk on “composting – why and how” followed by a live demonstration of the same. A pit was dug, and filled with layers of dung, vegetable waste from kitchen, dry leaves and finally covered on the top with soil. Children took part in this activity with great enthusiasm.

Compost pit demo at Muthurayanagar govt school

Prizes and certificates were given away in a valedictory function and Shri Darukesh concluded the day's program with an elegant vote of thanks. ISAC team returned with a deep sense of satisfaction of having sowed the seeds of Swacch Bharath in young minds, which are sure to bear fruit in due season.

CELEBRATION OF NATIONAL SCIENCE DAY – 2017

ISRO Satellite Centre celebrated National Science Day on 28th February. The day began with inauguration of events with lighting of the lamp by Director, ISAC. Students and teachers from various schools participated enthusiastically in the events that followed. It started with visit of all students to Mobile Science Exhibition from M/s Agastya International Foundation. It was a new attraction arranged outside main building and turned out to be huge success with lot of students showing interest in various scientific experiments on display. Mobile Planetarium from M/s Varnaaz Technologies got very good response from students and thrilled them with the shows based on astronomy and space. The students and teachers from various schools visited the space exhibition which had displays of various satellite models right from Aryabhata to Mars Orbiter Mission and exhibits related to space and satellite technology. The theme of this year's science day was “Science and technology for specially abled persons”.

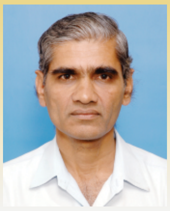
As part of the National Science Day celebrations, seven competitions were held for students from first to tenth standard classifying primary, middle and high school students as category A, B and C. A special teacher's event was also conducted. Essay writing to express their ideas on a given scientific topic around the theme of science day was conducted in Kannada, Hindi and English. In addition to regular prizes, Dr. K. Kasturirangan special prize was awarded to the best essay among the three languages for each of the two categories B and C. Test of Scientific Temper was an event held to test the answering ability of students of category C to questions related to normal day-to-day happenings around them. Teachers' Event was conducted on “Use of Science and Technology for Swachh Bharat Abhiyaan”, during which about 12 teachers made a presentation of their innovative ideas and their experience in implementation in their respective schools to motivate the student community. Extempore Science Elocution which tested the eloquence and ability of students to express scientific ideas was another attraction for category B and C students. Science in Action was an interesting event in which various experiments were demonstrated to the students and the underlying principle was sought. This event was aimed to expose the students to science, with the help of practical experiments and develop basic understanding of science and their applications. Innovative ideas contest was held to bring out scientific/technological innovations for specially-abled persons viz., “Making homes friendly for visually challenged through technology” for category B and "Specially-abled person's self-reliance through technology in school " for category C. Science quiz was held in two phases. Teams short-listed during the first phase of written test were allowed to compete for the final round. Spot painting saw lot of colorful creations from budding artists on Nature and students from middle school on the theme S&T for specially abled persons. Total of 1000 students and 140 teachers from various schools in Bengaluru participated in the above events.

The valedictory function began in the afternoon with a melodious invocation song which was followed by welcome address by Sri Basavaraj S Akkimaradi, Chairman, NSD-2017. Dr.P.Subba Rao, Alt. Chairman gave an insight into the life and achievements of Sir C.V. Raman in whose honour the event is celebrated. Dr. M Annadurai, Director, ISAC delivered the presidential address and stressed the role of students in taking the science and technology to greater heights. The Chief Guest for the occasion, Prof. Subrahmanyan Ravi, Director, Raman Reseach Institute, Bangalore, delivered the invited lecture titled “A journey to the far side of the Moon”. The talk was highly inspirational and well received. The program concluded with the distribution of prizes for winners by our Director and chief guest. The best performance trophy was won by Sindhi high school. The events and competitions were well organized by the conveners and members of the organizing committee. We thank everyone who had contributed directly or indirectly for a successful National Science Day celebration.

Basavaraj S Akkimaradi, Chairman, NSD-2017.
Dr. P Subba Rao, Alt.Chairman, NSD-2017.

ISRO Merit Award – 2012

Ekkundi R S


Govinda K V

Nagendra H R

Dr. Anand Kumar Sharma

Surya Narayana Sarma K

Dr. Nirmal Kumar Misra

ISRO Young Scientist Merit Awards-2012

Karthik A

C Koteshwar Rao

Motamarri Srikanth

Neetha Trimal

Niveditha B K

Prashant Kulshreshtha

Puneet Kumar Mishra

Veeresha D R

Satheesh P

Singaravelan S

Subba Rao Konduri

Vivek R Subramanian

ISRO Merit Award – 2013

Anantha Rama Sarma K B

Dakshyani B P

Dr. Nagendra Rao G

Sridhara C D

ISRO Young Scientist Merit Awards-2013

Atul Nigotia

Gaurav Sharma

Jagathipriya

Nazer Ahmad

Satyanaraya Kumari B

Sreekumar V

Sumith Shankar S

Vaddi Raghavaiah

Vinod Kumar

V Srinivasa Rao

ISRO Merit Award – 2014

Nagendra K

Natarajan P

ISRO Young Scientist Merit Awards-2014

Aditya Ganesh

Anoop Kumar Srivastava

Aras Kumar R

Balaji R

Kalpana B

Pradeesh Madhavan

Rahul Mishra

Sajiv Kumar J S

Venkata Sastry Vadlamani

Vivek Prabhakar

ISRO Merit Award – 2015

Prabhakar C A

Dr. Sriram K V

Subramanya Udupa

Vasantha Kumari U N

ISRO Young Scientist Merit Awards-2015

Vijay Shankar Rai

Hari Krishana Thota

Somasundaram S

Najeer Ahmmad Shiak

Namit Rarotra

Pawan Kumar Bhargav

Anshu Chauhan

S. Arun Kumar

Ashok Kumar Kakula

B Vishweshwar Rao

ಚಂದ್ರನ ಇಳಿಯಂತ್ರ : ಚಂದ್ರಯಾನ–೨ – ಭಾರತದ ಜೈತ್ರಯಾತ್ರೆಯ ತಯಾರಿಯಲ್ಲಿ...

ಅಂತರಿಕ್ಷ ಕ್ಷೇತ್ರದಲ್ಲಿ ನಡೆಯುತ್ತಿರುವ ನಿರಂತರ ವೈಜ್ಞಾನಿಕ, ತಾಂತ್ರಿಕ ಅನ್ವೇಷಣೆಯಲ್ಲಿ ಚಂದ್ರನ ಬಗೆಗಿನ ಕುತೂಹಲ ಸಹಜವಾದುದೇ. ಈ ನಿಟ್ಟಿನಲ್ಲಿ, ಚಂದ್ರಯಾನ–೧ ಯೋಜನೆಯು ತನ್ನ ಚೊಚ್ಚಲ ಪ್ರಯತ್ನದಲ್ಲಿಯೇ ನಮ್ಮ ತಾಂತ್ರಿಕ ಸಾಮರ್ಥ್ಯವನ್ನು ಪ್ರದರ್ಶಿಸಿದೆ. ಚಂದ್ರನ ಮೇಲ್ಮೈಯ ಅನ್ವೇಷಣೆಯ ಮುಂದಿನ ಹೆಜ್ಜೆಯಾಗಿ, ಚಂದ್ರನ ಮೇಲೆ ಇಳಿಯಬಲ್ಲ ಇಳಿಯಂತ್ರ (ಲ್ಯಾಂಡರ್) ಮತ್ತು ಚಂದ್ರನ ಮೇಲೆ ಸಂಚರಿಸಬಲ್ಲ ಸಂಚಾರಿ (ಉರುಳುಬಂಡಿ/ರೋವರ್)ಗಳು ಸೇರಿದಂತೆ ಚಂದ್ರಯಾನ–೨ಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ಅಭಿವೃದ್ಧಿಪಡಿಸಲಾಗುತ್ತಿರುವ ನೂತನ ತಂತ್ರಜ್ಞಾನಗಳನ್ನು ಕುರಿತು ಈ ಲೇಖನ.

ಚಿತ್ರ: ಚಂದ್ರನ ಮೇಲ್ಮೈ ಮೇಲೆ ಲ್ಯಾಂಡರ್ ಮತ್ತು ರೋವರ್

ಲ್ಯಾಂಡರ್ ಒಂದು ವ್ಯೋಮನೌಕೆಯಾಗಿದ್ದು, ಚಂದ್ರನ ಮೇಲೆ ನಿಧಾನವಾಗಿ ಇಳಿದು ನೆಲೆನಿಲ್ಲಬಲ್ಲದು. ಲ್ಯಾಂಡರ್ ಇಳಿಯುವಾಗ, ಅದರ ಮತ್ತು ಆಕಾಶಕಾಯದ ನಡುವಿನ ಸಾಪೇಕ್ಷ ವೇಗದಲ್ಲಿನ ಅಂತರವನ್ನು ಕಡಿಮೆಮಾಡುವುದಕ್ಕಾಗಿ, ಲ್ಯಾಂಡರಿನಲ್ಲಿಯೇ ಅಳವಡಿಸಲಾಗುವ ಸಣ್ಣ ರಾಕೆಟ್ಟುಗಳ ಮೂಲಕ ವೇಗವನ್ನು ತಡೆದು ಮೃದು ಸ್ಪರ್ಶವನ್ನು ಸಾಧಿಸಲಾಗುತ್ತದೆ. ಲ್ಯಾಂಡರ್ ಮೇಲ್ಮೈ ಸ್ಪರ್ಶಸಮಯದಲ್ಲಿ ಸ್ವಲ್ಪ ಮಟ್ಟಿಗಿನ ಅಪ್ಪಳಿಕೆಯನ್ನು ಅನುಭವಿಸುತ್ತದೆ. ಈ ಅಪ್ಪಳಿಕೆಯ ಬಲವು ಲ್ಯಾಂಡರಿನ ಇತರೆ ಭಾಗಗಳಿಗೆ ಹಾನಿಮಾಡದಂತೆ ಸಂರಕ್ಷಿಸಲು, ಸಂಯಂತ್ರಯುತ ಕಾಲುಗಳನ್ನು ಅಥವಾ ನಿಗದಿತ ಸಮಯದಲ್ಲಿ ಉಬ್ಬಬಲ್ಲ ವಾಯುಚೀಲಗಳನ್ನು ಅಳವಡಿಸಲಾಗುತ್ತದೆ.

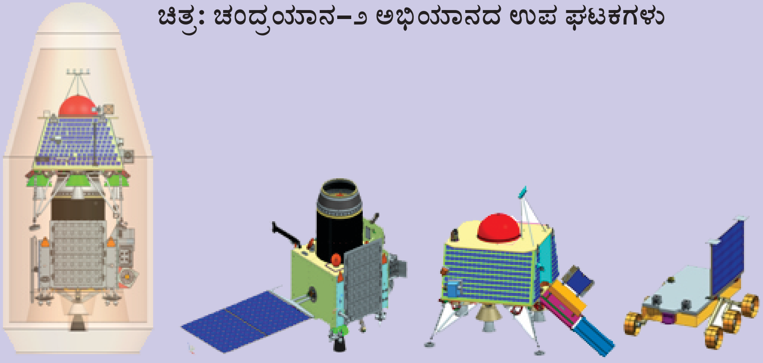
ರೋವರ್, ಒಂದು ಅನ್ವೇಷಕ ವಾಹನವಾಗಿದ್ದು, ಚಂದ್ರನ ಮೇಲ್ಮೈಯಲ್ಲಿ ಸಂಚರಿಸುವಂತೆ ವಿನ್ಯಾಸಗೊಳಿಸಲಾಗಿರುತ್ತದೆ. ಅದು ತನ್ನ ಕಾರ್ಯವನ್ನು, ಭಾಗಶಃ ಅಥವಾ ಸಂಪೂರ್ಣ ಸ್ವಾಯತ್ತತೆಯಿಂದ ನಿರ್ವಹಿಸುವಂತೆ ವಿನ್ಯಾಸ ಗೊಳಿಸಲಾಗಿರುತ್ತದೆ.

ಏಕೆ ಚಂದ್ರನೆಡೆಗೆ? : ವಿಖ್ಯಾತ ರಾಕೆಟ್ ತಂತ್ರಜ್ಞರಾದ, ವೆರ್ನರ್ ಫಾನ್ ಬ್ರೌನ್, ಪ್ರಖ್ಯಾತ ವಿಜ್ಞಾನ ಕಾಲ್ಪನಿಕ ಬರಹಗಾರ, ಆರ್ಥರ್ ಸಿ. ಕ್ಲಾರ್ಕ್ ಹಾಗೂ ತೀರ ಇತ್ತೀಚಿನ ಮತ್ತೊಬ್ಬ ಪ್ರಖ್ಯಾತ ಗ್ರಹವಿಜ್ಞಾನಿಯಾದ, ಪೌಲ್ ಡಿ. ಸ್ಪುಡಿಸ್‌ರು ಚಂದ್ರನೆಡೆಗೆ ಸಾಗಿ ಗಾಳಿ ಮತ್ತು ನೀರಿನ ಉತ್ಪಾದನೆ ಮುಂತಾದ ಕಾರ್ಯಗಳನ್ನು ಸಾಧಿಸುವುದರ ಮೂಲಕ ಜನರು ಅಲ್ಲಿ ವಾಸಮಾಡಬಹುದೆಂಬ ದಾರ್ಶನಿಕ ಕಲ್ಪನೆಗಳನ್ನು ಮುಂದಿಟ್ಟಿದ್ದಾರೆ. ಹಾಗೆಯೇ, ಅಲ್ಲಿನ ಸಂಪನ್ಮೂಲಗಳನ್ನು ಬಳಸಿಕೊಂಡು ರಾಕೆಟ್ಟುಗಳಿಗೆ ಮರುಇಂಧನ ಪೂರೈಕೆ ಮಾಡಿಕೊಳ್ಳುವುದರ ಮೂಲಕ ಸೂರ್ಯಮಂಡಲದಲ್ಲಿನ ಇತರೆ ಗ್ರಹಗಳ ಅಧ್ಯಯನದಲ್ಲಿ ತೊಡಗಲಿರುವ ಯಾಂತ್ರಿಕ ಮತ್ತು ಮಾನವಸಹಿತ ಯೋಜನೆಗಳಿಗೆ ಹೇಗೆ ಚಂದ್ರ ಚಿಮ್ಮುನೆಲೆಯಾಗಬಹುದು ಎಂಬುದರ ಬಗ್ಗೆ ಸುದೀರ್ಘವಾಗಿ ಚರ್ಚಿಸಿದ್ದಾರೆ.

ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನದ ದೃಷ್ಟಿಯಿಂದ, ಲ್ಯಾಂಡರ್ ಮತ್ತು ರೋವರ್‌ಗಳಿಗೆ ಸಂಬಂಧಪಟ್ಟಂತೆ ಅತ್ಯಾಧುನಿಕ ತಂತ್ರಜ್ಞಾನಗಳ ಅಭಿವೃದ್ಧಿಯು ಈ ಕಾರ್ಯಯೋಜನೆಗಳ ಪ್ರಾಥಮಿಕ ಚಾಲಕ ಶಕ್ತಿಯಾಗಿವೆ. ಚಂದ್ರನಲ್ಲಿ ಶುದ್ಧ ಮತ್ತು ದಕ್ಷ ರೀತಿಯಲ್ಲಿ ಶಕ್ತಿಯ ಉತ್ಪಾದನೆಯ ಸಾಧ್ಯತೆಯು ಈ ಕಾರ್ಯಯೋಜನೆಗಳಿಗೆ ಪ್ರೇರೇಪಣೆ. ಚಂದ್ರನಲ್ಲಿ ವಿಪುಲವಾಗಿ ದೊರೆಯುವ ಹೀಲಿಯಮ್–೩ ಸಮಸ್ಥಾನಿಯು ವಿಕಿರಣರಹಿತವಾಗಿದ್ದು, ಅಪಾಯಕಾರಿ ತ್ಯಾಜ್ಯವಸ್ತುಗಳನ್ನು ಹೊರಹಾಕುವುದಿಲ್ಲವಾದ್ದರಿಂದ, ಸುರಕ್ಷಿತ ಬೈಜಿಕ ಶಕ್ತಿಯ ಉತ್ಪಾದನೆಗೆ ಎಡೆಮಾಡಿಕೊಡಬಲ್ಲುದೆಂದು ಭಾವಿಸಲಾಗಿದೆ. ಹಾಗೆಯೇ, ಒಂದು ಶಾಶ್ವತ ಅಂತರಿಕ್ಷ ಸಾಗಾಣಿಕೆ ವ್ಯವಸ್ಥೆಯನ್ನು ಸ್ಥಾಪಿಸಲು ಬೇಕಾದ ಎಲ್ಲ ಸಂಪನ್ಮೂಲಗಳನ್ನು ಹೊಂದಿರುವುದರಿಂದ, ಬಾಹ್ಯಾಕಾಶ ಅನ್ವೇಷಣೆಯಲ್ಲಿ ಚಂದ್ರನಿಗೆ ಸಾಕಷ್ಟು ಮಹತ್ವವಿದೆ. ಚಂದ್ರನ ಅತಿಶೀತಲ ಶಾಶ್ವತ ಕಪ್ಪುಕುಳಿಗಳಲ್ಲಿರುವ ಘನೀಭೂತ ನೀರು ಮತ್ತು ಅದರ ಧ್ರುವ ಪ್ರದೇಶದ ಎತ್ತರದ ಶಿಖರಗಳಲ್ಲಿ ಬಹುತೇಕ ಶಾಶ್ವತ ಲಭ್ಯವಿರುವ ಸೂರ್ಯನ ಬೆಳಕು, ಮುಂದಿನ ದಿನಗಳಲ್ಲಿ ಅತ್ಯಂತ ಮಹತ್ವದ ಪಾತ್ರವನ್ನು ವಹಿಸಲಿವೆ. ಅಂತರಿಕ್ಷದ ಕಠಿಣತಮ ಪರಿಸರದಲ್ಲಿ, ನೀರು ಮತ್ತು ಶಕ್ತಿಯ ನಿರಂತರ ಉಪಲಬ್ಧತೆ ಎಷ್ಟು ಉಪಯುಕ್ತವಾಗಬಲ್ಲುದೆಂದು ಊಹಿಸಬಲ್ಲುದಾಗಿದೆ. ಇವು, ಚಂದ್ರಯಾನ–೧ ಸೇರಿದಂತೆ, ಇತ್ತೀಚಿನ ಕಾರ್ಯಯೋಜನೆಗಳ ಮೂಲಕ ಲಭ್ಯವಾದ ಮಾಪನಗಳಿಂದ ವೈಜ್ಞಾನಿಕವಾಗಿ ದೊರಕಿರುವ ಅತ್ಯುಪಯುಕ್ತ ಮಾಹಿತಿಯಾಗಿವೆ.

ಮುಂದಿನ ೫೦–೬೦ ವರ್ಷಗಳಲ್ಲಿ, ಅಲ್ಲಿಯ ಅತಿಶೀತಲ ಪ್ರದೇಶಗಳಲ್ಲಿನ ಘನೀಭೂತವಾದ ನೀರನ್ನು ಶಕ್ತಿಯ ಆಕರವಾಗಿಯೂ, ಇಂಧನವಾಗಿಯೂ ಪರಿವರ್ತಿಸುವ ಕೇಂದ್ರಗಳನ್ನು ಚಂದ್ರನ ಧ್ರುವ ಪ್ರದೇಶಗಳಲ್ಲಿ ಸ್ಥಾಪಿಸಲು ಸಾಧ್ಯವಾಗಬಹುದು. ಈ ಉದ್ದೇಶ ಸಾಧನೆಗೆ, ಭೂಮಿಯಿಂದ ಚಂದ್ರನೆಡೆಗೆ ಮತ್ತು ಅಲ್ಲಿಂದ ಭೂಮಿ ಮತ್ತು ಇತರ ಗ್ರಹಗಳೆಡೆಗೆ ಸಾಗಬಲ್ಲಂತಹ, ಚಂದ್ರನಲ್ಲಿ ದೊರಕುವ ಇಂಧನ ಮತ್ತು ಇತರೆ ಸಂಪನ್ಮೂಲಗಳನ್ನು ಉಪಯುಕ್ತವಾಗಿ ಬಳಸಬಲ್ಲಂತಹ ಲ್ಯಾಂಡರುಗಳ ಅಭಿವೃದ್ಧಿ ಅತ್ಯವಶ್ಯವಾಗಿದೆ.

ಚಂದ್ರಯಾನ–೨ ಕಾರ್ಯಯೋಜನೆ: ಚಂದ್ರಯಾನ–೨ ಕಾರ್ಯಯೋಜನೆಯು ಕಕ್ಷಾ ಅಭಿಯಾನ ಅಥವಾ ಚಂದ್ರನ ಉಪಗ್ರಹ ಮತ್ತು ಲ್ಯಾಂಡರನ್ನು ಒಳಗೊಂಡಿದ್ದು, ಸಂಯುಕ್ತಕವೆಂದು ಕರೆಯಲ್ಪಡುತ್ತದೆ. ಈ ಉಪಗ್ರಹ–ಸಂಯುಕ್ತಕವನ್ನು ಜಿಎಸ್.ಎಲ್.ವಿ.–ಮಾರ್ಕ್–೩ ರಾಕೆಟ್ ಮೂಲಕ ಉಡಾಯಿಸಲಾಗುವುದು. ಕಕ್ಷಾ ಅಭಿಯಾನವು ತನ್ನಲ್ಲಿ ಒಳಗೊಂಡಿರುವ ಸಣ್ಣ ಉಡ್ಡಯಕದ ನೆರವಿನಿಂದ ಭೂಮಿಯ ಸುತ್ತಲಿನ ತನ್ನ ದೀರ್ಘ ವೃತ್ತಾಕಾರದ ಕಕ್ಷೆಯ ಎತ್ತರವನ್ನು ಏರಿಸುತ್ತಾ ಚಂದ್ರ ವರ್ಗಾವಣಾ ಕಕ್ಷೆಗೆ ವರ್ಗಾಯಿಸಲ್ಪಡುತ್ತದೆ. ಸಂಯುಕ್ತಕವು, ನಿಖರವಾದ ಕಕ್ಷಾಪಲ್ಲಟ ಕಾರ್ಯತಂತ್ರದ ನೆರವಿನಿಂದ ಚಂದ್ರನ ಕಕ್ಷೆಗೆ ವರ್ಗಾಯಿಸಲ್ಪಡುತ್ತದೆ. ನಂತರದಲ್ಲಿ, ಚಂದ್ರನ ಸುತ್ತಲಿನ ಸಂಯುಕ್ತಕದ ಕಕ್ಷೆಯನ್ನು, ಚಂದ್ರನ ಮೇಲೆ ಲ್ಯಾಂಡರ್ ನಿರ್ಧಾರಿತ ಸ್ಥಳದಲ್ಲಿ ಇಳಿಯಲು ಅನುಕೂಲವಾಗುವಂತೆ ಹಾಗೂ ಕಕ್ಷೆಯು ೧೦೦ ಕಿ.ಮೀ. ಎತ್ತರದಲ್ಲಿ ವೃತ್ತಾಕರದಲ್ಲಿರುವಂತೆ ಸರಿಪಡಿಸಲಾಗುತ್ತದೆ. ಲ್ಯಾಂಡರಿನ ಮತ್ತು ಕಕ್ಷಾ ಅಭಿಯಾನದ ಜೀವಿತಾವಧಿಯನ್ನು ಗರಿಷ್ಟಗೊಳಿಸಲು ಯೋಜನಾ ಉಡಾವಣಾ ದಿನಾಂಕ ಮತ್ತು ಚಂದ್ರ ಕಕ್ಷಾ ಸೇರ್ಪಡೆಯ ದಿನಾಂಕ ಮತ್ತು ಸ್ಥಾನವನ್ನು ಅತ್ಯಂತ ನಿಖರವಾಗಿ ನಿಗದಿಪಡಿಸಲಾಗುತ್ತದೆ. ಈ ನಿಬಂಧನೆಗಳನ್ನು ಸಾಧಿಸಲು, ಉಡಾವಣಾ ಕಕ್ಷಾ



ಚಿತ್ರ: ಚಂದ್ರಯಾನ-೨ ಅಭಿಯಾನದ ಉಪ ಘಟಕಗಳು

ಅಳವಡಿಕೆಯ ನಿಯತಾಂಕಗಳು, ಕಕ್ಷಾ ಎತ್ತರವನ್ನು ಏರಿಸುವ ಪ್ರಕ್ರಿಯೆಗಳು ಮತ್ತು, ಸೂರ್ಯ ಮತ್ತು ಭೂಮಿಗೆ ಸಂಬಂಧಿಸಿದಂತೆ, ಚಂದ್ರ ಕಕ್ಷಾ ಅಳವಡಿಕೆಯ ಜ್ಯಾಮಿತಿಯನ್ನು ಅತ್ಯಂತ ನಿಖರವಾಗಿ ನಿರ್ಧರಿಸಲಾಗುತ್ತದೆ.

ಸಂಯುಕ್ತಕವು, ಲ್ಯಾಂಡರಿನಿಂದ ಬೇರ್ಪಡೆಗೊಳ್ಳುವ ಸ್ಥಾನದಲ್ಲಿ ಸರಿಯಾದ ಸಮಯದಲ್ಲಿ ಇರುವಂತೆ ನೋಡಿಕೊಳ್ಳಲು, ಚಂದ್ರನ ಸುತ್ತ ಪರಿಭ್ರಮಿಸುತ್ತಿರುವ ಸಂಯುಕ್ತಕದ ಕಕ್ಷಾ ನಿಯತಾಂಕಗಳನ್ನು ನಿಖರವಾಗಿ ನಿರ್ಧರಿಸಿ ಬೇಕಾದಲ್ಲಿ ಸರಿಪಡಿಸಬೇಕಾಗುತ್ತದೆ. ಸಂಯುಕ್ತಕವು ನಿಗದಿಪಡಿಸಿದ ಸಮಯ ಮತ್ತು ಕಕ್ಷಾಸ್ಥಾನವನ್ನು ತಲುಪಿದ ತಕ್ಷಣ, ಕಕ್ಷಾ ಅಭಿಯಾನ ಮತ್ತು ಲ್ಯಾಂಡರ್‌ಗಳನ್ನು ಬೇರ್ಪಡಿಸಲಾಗುತ್ತದೆ.

ಚಂದ್ರ ಕಕ್ಷಾ ಅಭಿಯಾನವು ತನ್ನ ನಿಗದಿತ ವೈಜ್ಞಾನಿಕ ಅನ್ವೇಷಣೆಯನ್ನು ಚಂದ್ರನ ಸುತ್ತಲಿನ ತನ್ನ ಕಕ್ಷೆಯಲ್ಲಿ ಮುಂದುವರಿಸುತ್ತದೆ. ಬೇರ್ಪಡೆಯಾದ ನಂತರದಲ್ಲಿ, ಸೆಕೆಂಡಿಗೆ ೧.೭ ಕಿ.ಮೀ. ವೇಗದಲ್ಲಿ ಚಂದ್ರನ ಸುತ್ತ ಪರಿಭ್ರಮಿಸುತ್ತಿರುವ ಲ್ಯಾಂಡರನ್ನು ಚಂದ್ರನ ಮೇಲ್ಮೈಯೆಡೆಗೆ ಸಾಗುವಂತೆ (ಹೊಫ್ಮನ್ ವರ್ಗಾವಣಾ ವಿಧಾನದಲ್ಲಿ) ಜಡತ್ವಾಧಾರಿತ ಯಾನನಿರ್ಧಾರಣಾ ವ್ಯವಸ್ಥೆಯ ಸಹಾಯದಿಂದ, ಅದರಲ್ಲಿ ಒಳಗೊಂಡಿರುವ ಸಣ್ಣ ರಾಕೆಟ್ಟನ್ನು ಬಳಸಿಕೊಂಡು, ಅದರ ವೇಗವನ್ನು ಕಡಿಮೆ ಮಾಡಿ ಚಂದ್ರನ ಸುತ್ತ ೧೦೦ ಕಿ.ಮೀ ಪಥ ೧೮ ಕಿ.ಮೀ. ಎತ್ತರದ ದೀರ್ಘವೃತ್ತಾಕಾದರ ಕಕ್ಷೆಗೆ ವರ್ಗಾಯಿಸಲಾಗುತ್ತದೆ. ಲ್ಯಾಂಡರ್ ಘಟಕವು ಪೂರ್ವನಿಗದಿಯಂತೆ, ೧೮ ಕಿ.ಮೀ. ಹತ್ತಿರದಲ್ಲಿ ಬರುತ್ತಿದ್ದಂತೆ, ಸ್ಥೂಲ ವೇಗತಡೆ ಹಂತವನ್ನು ಪ್ರಾರಂಭಿಸಲಾಗುತ್ತದೆ. ಈ ಅವಧಿಯಲ್ಲಿ, ಲ್ಯಾಂಡರಿನ ನಿಲುವನ್ನು ಕರಾರುವಾಕ್ಕಾಗಿ ನಿಯಂತ್ರಣದಲ್ಲಿರಿಸಲಾಗುತ್ತದೆ. ಜಡತ್ವ ಸಂವೇದಕಗಳಿಂದ ದೊರೆತ ಮಾಪನಗಳನ್ನಾಧರಿಸಿ, ಜಡತ್ವಾಧಾರಿತ ನಿರ್ದೇಶನ ಮತ್ತು ನಿಯಂತ್ರಣ ವ್ಯವಸ್ಥೆಯು, ನಿಖರ ಸಂಕೇತಗಳನ್ನು ತಡೆಶಕ್ತಿಯನ್ನು ಒಡ್ಡುತ್ತಿರುವ ಚಾಲಕ ಯಂತ್ರಗಳಿಗೆ ರವಾನಿಸುತ್ತದೆ. ಚಾಲಕ ಯಂತ್ರಗಳು, ಈ ಸಂಕೇತಗಳಿಗೆ ಅನುಸಾರವಾಗಿ, ವೇಗನಿರೋಧವನ್ನು ನಿಯಮಿತವಾಗಿ ಒಡ್ಡುತ್ತಿರುತ್ತವೆ. ಚಂದ್ರನ ಮೇಲ್ಮೈಗೆ ೭ ಕಿ.ಮೀ. ಹತ್ತಿರಕ್ಕೆ ಬರುತ್ತಿದ್ದಂತೆ, ಈ ಹಂತವು ಕೊನೆಗೊಂಡು, ಅಪಾಯ ನಿರೋಧ ಸಂವೇದಕಗಳು, ಲ್ಯಾಂಡರ್ ಇಳಿಯಬೇಕಾದ ನಿಖರವಾದ ಸ್ಥಾನಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ, ಲ್ಯಾಂಡರಿನ ತತ್ಕಾಲೀನ ಸ್ಥಾನ ಮತ್ತು ವೇಗವನ್ನು ನಿರ್ಧರಿಸುತ್ತದೆ. ತತ್ಕಾಲೀನ ಸ್ಥಾನ ಮತ್ತು ಗಮ್ಯಸ್ಥಾನಕ್ಕೆ ಇರುವ ಅಂತರಕ್ಕೆ ಅನುಗುಣವಾಗಿ, ಲ್ಯಾಂಡರಿನ ಮುಂದಿನ ಮಾರ್ಗವನ್ನು, ಲ್ಯಾಂಡರಿನ ಒಳಗಿರುವ ಸ್ವಾಯತ್ತ ಕಂಪ್ಯೂಟರ್‌ಗಳು ನಿರ್ಧರಿಸುತ್ತವೆ. ನಂತರದಲ್ಲಿ, ಲ್ಯಾಂಡರಿನ ಚಾಲಕ ಯಂತ್ರಗಳು, ಲ್ಯಾಂಡರ್ ಇಳಿಯಬೇಕಾದ ಗಮ್ಯಸ್ಥಾನದ ಮೇಲೆ ೧೦೦ ಮೀ. ಎತ್ತರಕ್ಕೆ ತಂದು ನಿಲ್ಲಿಸುತ್ತವೆ. ಈ ಸಮಯದಲ್ಲಿ, ಲ್ಯಾಂಡರ್, ತನ್ನ ಸ್ಥಾನದಲ್ಲಿ ಇರುವಂತೆ, ಅದರಲ್ಲಿನ ಅಪಾಯ ನಿರೋಧ ಸಂವೇದಕಗಳು, ಗಮ್ಯ ಸ್ಥಾನದ ಸುತ್ತುಮುತ್ತಲಿನ ಮೇಲ್ಮೈಯನ್ನು ಪರಾಮರ್ಶಿಸಿ, ಲ್ಯಾಂಡರ್ ಸುರಕ್ಷಿತವಾಗಿ ಇಳಿಯಲು ನಿಖರವಾದ ಸ್ಥಾನವನ್ನು ಗೊತ್ತು ಮಾಡುತ್ತದೆ. ಈ ಸ್ಥಾನದ ಮೇಲೆ, ಕೇವಲ ೨ ಮೀ ಎತ್ತರಕ್ಕೆ ಲ್ಯಾಂಡರನ್ನು ಸೂಕ್ಷ್ಮ ನಿರ್ದೇಶನದೊಂದಿಗೆ, ತರಲಾಗುತ್ತದೆ ಹಾಗೂ ಚಂದ್ರನ ಮೇಲ್ಮೈಗೆ ಸಂಬಂಧಪಟ್ಟಂತೆ, ಸಾಪೇಕ್ಷ ವೇಗವನ್ನು, ಪೂರ್ತಿ ನಿರೋಧಿಸಿ ಅಂದರೆ, ೦ ಕಿ.ಮೀ.ಗೆ ಇಳಿಸಲಾಗುತ್ತದೆ. ಲ್ಯಾಂಡರನ್ನು ಈ ಸಮಯದಲ್ಲಿ ಸ್ಥಾನದ ಮೇಲೆ ಯಾವುದೇ ನಿರ್ಬಂಧಗಳಿಲ್ಲದೆ ಬೀಳಿಸಿ ಲ್ಯಾಂಡರಿನಲ್ಲಿ ಅಳವಡಿಸಲಾದ ಕಾಲುಗಳ ಮೇಲೆ ನಿಲ್ಲುವಂತೆ ಮಾಡಲಾಗುತ್ತದೆ. ಲ್ಯಾಂಡರ್‌ಗೆ ಅಳವಡಿಸಲಾದ ಕಾಲುಗಳು ಈ ಬೀಳುವಿಕೆಯ ಅಘಾತವನ್ನು ತಡೆದು ಲ್ಯಾಂಡರಿಗೆ ಯಾವುದೇ ಹಾನಿಯಾಗದಂತೆ ನೋಡಿಕೊಳ್ಳುತ್ತದೆ.

ಲ್ಯಾಂಡರ್, ಸಂಯುಕ್ತಕದಿಂದ ಬೇರ್ಪಟ್ಟು, ತನ್ನ ಸ್ಥಾನದಲ್ಲಿ ನಿಲ್ಲುವವರೆಗೂ ಆಗುವ ಎಲ್ಲ ಕಾರ್ಯಗಳನ್ನು ಅದರಲ್ಲಿಯೇ ಅಳವಡಿಸಿರುವ ಕಂಪ್ಯೂಟರ್, ಭೂಕೇಂದ್ರದ ಸಹಾಯವಿಲ್ಲದೆ, ಸ್ವಾಯತ್ತವಾಗಿ ನೆರವೇರಿಸುತ್ತದೆ. ಆದರೆ, ದೂರಮಾಪನ ವ್ಯವಸ್ಥೆಯ ಮೂಲಕ, ಲ್ಯಾಂಡರಿನ ಎಲ್ಲ ಸಂವೇದಕಗಳ ಮಾಹಿತಿಯು ಭೂಕೇಂದ್ರಕ್ಕೆ ರವಾನೆಯಾಗುತ್ತಿರುತ್ತದೆ. ಇದರಿಂದಾಗಿ ಲ್ಯಾಂಡರಿನ ಮೇಲೆ ನಿಯಂತ್ರಣವಿಲ್ಲದಿದ್ದರೂ, ಅದು ಗಮ್ಯಸ್ಥಾನವನ್ನು ತಲುಪುವವರೆಗಿನ ಮಾಹಿತಿಯು ನಿರಂತರವಾಗಿ ಭೂಕೇಂದ್ರದಲ್ಲಿ ದಾಖಲಾಗುತ್ತಿರುತ್ತದೆ. ಲ್ಯಾಂಡರಿನಲ್ಲಿಯೂ ಕೂಡ ವೈಜ್ಞಾನಿಕ ಉಪಕರಣಗಳಿದ್ದು, ಪ್ರಯೋಗಗಳನ್ನು ನಡೆಸಲು ಅನುಕೂಲಕರವಾಗಿದೆ, ಹಾಗೂ ಈ ಪ್ರಯೋಗಗಳ ಫಲಿತಾಂಶವನ್ನು ಭೂಕೇಂದ್ರಕ್ಕೆ ರವಾನಿಸಲು ಬೇಕಾದ ವ್ಯವಸ್ಥೆಯನ್ನು ಅಳವಡಿಸಲಾಗಿರುತ್ತದೆ.

ಚಂದ್ರನ ಮೇಲೆ ಲ್ಯಾಂಡರ್ ಸುಸ್ಥಿತಿಯಲ್ಲಿ ನೆಲೆಗೊಂಡನಂತರ, ಅದು ತನ್ನಲ್ಲಿರುವ ರೋವರನ್ನು ಚಂದ್ರನ ಮೇಲ್ಮೈ ಮೇಲೆ ಹರಿಯಬಿಡುತ್ತದೆ. ಚಂದ್ರನ ಮೇಲ್ಮೈಯನ್ನು ಆವರಿಸಿರುವ ಧೂಳು, ಮಣ್ಣು, ಬಿಡಿಯಾದ ಕಲ್ಲಿನ ಚೂರುಗಳು ಮುಂತಾದ ಮೇಲ್ಮೈ ಪದರಕ್ಕೆ ರೆಗೊಲಿತ್ ಎಂದು ಕರೆಯುತ್ತಾರೆ. ಚಂದ್ರನ ಮೇಲ್ಮೈಯಲ್ಲಿ ಇರುವ ರೆಗೊಲಿತ್‌ನ ಭೌತಿಕ ಮತ್ತು ಗಡಸುತನ ಮುಂತಾದ ಲಕ್ಷಣಗಳು, ರೋವರ್ ಚಂದ್ರನ ಮೇಲೆ ಸಂಚರಿಸಲು ಸಮಯಾನುಸಾರ ಅದು ಸಂಚರಿಸುತ್ತಿರುವ ಸ್ಥಳವನ್ನಾಧರಿಸಿ ಕೆಲವು ವೇಳೆ ಅನುಕೂಲಕರ ಅಥವಾ ಕೆಲವು ವೇಳೆ ಪ್ರತಿಕೂಲಕರವಾಗಿ ಪರಿಣಮಿಸುತ್ತವೆ. ರೋವರ್‌ನಲ್ಲಿ ಅಳವಡಿಸಲಾದ ಪಥದರ್ಶನ ಸಂವೇದಕಗಳು, ಭಾಗಶಃ ಸ್ವಾಯತ್ತತೆಯಿಂದ ಕೂಡಿದ್ದು, ರೋವರ್ ಚಂದ್ರನ ಮೇಲೆ ಸಂಚರಿಸಲು ಅನುವು ಮಾಡಿಕೊಡುತ್ತದೆ. ಹಾಗೆಯೇ ಭೂಕೇಂದ್ರದಿಂದ ರೋವರಿಗೆ ಬರುವ ನಿರ್ದೇಶನಗಳನ್ನು ಪರಿವರ್ತಿಸಲೂ ಸಹಾಯಮಾಡುತ್ತದೆ. ರೋವರ್ ಕೇವಲ ಸಂಚಾರಿಯಾಗಿರದೆ, ತನ್ನೊಳಗೆ ಅನೇಕ ವೈಜ್ಞಾನಿಕ ಪ್ರಯೋಗಾಲಯಗಳನ್ನು ಒಳಗೊಂಡಿದ್ದು, ಸಂಚರಿಸುವಾಗಲೇ ಪ್ರಯೋಗಗಳನ್ನು ನಡೆಸಿ, ಅದರ ಫಲಿತಾಂಶಗಳನ್ನು, ಲ್ಯಾಂಡರಿನ ಮೂಲಕ ಭೂಕೇಂದ್ರಕ್ಕೆ ರವಾನಿಸುತ್ತದೆ.

ಉಪಗ್ರಹ, ಲ್ಯಾಂಡರ್ ಮತ್ತು ರೋವರ್ ಮೂರನ್ನೂ ಒಳಗೊಂಡ ಯೋಜನೆಯು ಬಹುಕ್ಲಿಷ್ಟಕರ ಹಾಗೂ ಅತ್ಯಂತ ಸವಾಲಿನದ್ದಾಗಿದೆ. ಇದಕ್ಕಾಗಿ, ಅನೇಕ ಹೊಸ ತಂತ್ರಜ್ಞಾನಗಳನ್ನು ಮತ್ತು ವ್ಯವಸ್ಥೆಗಳನ್ನು ವಿನ್ಯಾಸಗೊಳಿಸಿ ನಿರ್ಮಿಸಬೇಕಾಗುತ್ತದೆ. ಇವುಗಳಲ್ಲಿ, ಲ್ಯಾಂಡರ್ ಇಳಿಯುವ ಸ್ಥಳದ

ನಿರ್ಧರಣೆ, ಅಪಾಯ ನಿರೋಧಕ ಸಂವೇದಕಗಳ ಅಭಿವೃದ್ಧಿ, ಇಳಿಯುವಾಗಿನ ಸ್ವಾಯತ್ತ ಪಥನಿರ್ದೇಶನ ತಂತ್ರಜ್ಞಾನದ ಅಭಿವೃದ್ಧಿ, ಲ್ಯಾಂಡರಿನ ತಡೆ ಚಾಲಕಗಳ ಅಭಿವೃದ್ಧಿ, ಲ್ಯಾಂಡರಿನ ಸಂಯಂತ್ರಯುತ ಪಾದಗಳು, ಲ್ಯಾಂಡರಿನ ವಿದ್ಯುತ್ ಶಕ್ತಿವ್ಯವಸ್ಥೆ, ಸಂಪೂರ್ಣ ರೋವರ್ ವ್ಯವಸ್ಥೆಗಳಲ್ಲದೆ, ಇವೆಲ್ಲವುಗಳ ಕಾರ್ಯಕ್ಷಮತೆಯನ್ನು ಪರೀಕ್ಷಿಸಲು ಬೇಕಾದ ವಿಶೇಷ ಪರೀಕ್ಷಾವಿಧಾನಗಳ ಅಭಿವೃದ್ಧಿಯೂ ಸೇರಿವೆ.

ಹೀಗೆ, ಚಂದ್ರಯಾನ–೨ ಯೋಜನೆಯು, ಅನೇಕ ತಾಂತ್ರಿಕ ಆವಿಷ್ಕಾರಗಳಿಗೆ ಅನುವುಮಾಡಿಕೊಡುತ್ತಿದ್ದು, ಇಸ್ರೋದ ಪಾಲಿಗೆ ಅತ್ಯಂತ ಸವಾಲಿನದ್ದಾಗಿದೆ. ಹಾಗೂ, ಬರುವ ದಶಕಗಳಲ್ಲಿ, ಬಾಹ್ಯಾಕಾಶ ಸಂಶೋಧನೆಯಲ್ಲಿ ಅತ್ಯಂತ ಮಹತ್ವದ ಹೆಜ್ಜೆಯಾದ ಅಂತರ ಗ್ರಹ ಅನ್ವೇಷಣೆಗೆ ಮುನ್ನುಡಿ ಬರೆಯಲು ಸಜ್ಜಾಗುತ್ತಿದೆ.

ಲೇಖಕರು: ಡಾ. ಜಿ ನಾಗೇಶ್, ಡಾ. ಎಂ. ಅಣ್ಣಾದುರೈ
ಅನುವಾದಕರು: ಜಗದೀಶ ಬಾಬು ಬಿ. ಎಸ್.

राजभाषा अभिमुखीकरण कार्यक्रम

इसरो उपग्रह केन्द्र में 27 जनवरी 2017 को राजभाषा अभिमुखीकरण कार्यक्रम का आयोजन किया गया। कार्यक्रम का उद्घाटन समारोह 10.00 बजे को एम.ओ.सी.सी. सम्मेलन कक्ष में आयोजित किया गया। श्री बी.आर. राजपूत, संयुक्त निदेशक (राभा), अंतरिक्ष विभाग, अतिथि के रुप में उपस्थित रहे।

इस कार्यक्रम का आगाज़ श्रीमती नलिनी प्रकाश की वंदना के साथ किया गया। श्री मनोहर एल. वाणियर, वरिष्ठ प्रधान कार्मिक व सामान्य प्रशासन ने सभा में उपस्थित सभी आमंत्रितों एवं प्रतिभागियों का स्वागत करते हुए कहा कि राजभाषा अभिमुखीकरण कार्यक्रम का आयोजन राजभाषा कार्मिकों को प्रोत्साहित एवं उन्हें हिंदी के प्रचार-प्रसार की नई विचारधाराओं एवं राजभाषा विभाग के आदेशों से परिचित कराने के लिए किया गया है।

श्री अनूप श्रीवास्तव, नियंत्रक, आईज़ेक ने अपने संबोधन में कहा कि आईज़ेक में इसरो के विभिन्न केन्द्र/यूनिटों के सभी राजभाषा कार्मिकों के लिए राजभाषा अभिमुखीकरण कार्यक्रम का आयोजन बहुत ही खुशी की बात है। अंतरिक्ष विभाग के तकनीकी विषयों को सहज एवं सरल हिंदी में देश के कोने-कोने तक पहुँचाना ही इस कार्यक्रम का मुख्य उद्देश्य है। अत: इस उद्देश्य को सार्थक करने हेतु श्री राधेश्याम गुप्ता, विशेष कार्याधिकारी व हिंदी अधिकारी-II, पी.आर.एल., अहमदाबाद से **Google Voice typing & Machine translation** एवं श्री अशोक कुमार बिल्लूरे, सेवा निवृत्त संयुक्त निदेशक (राभा.), अं.वि., बेंगलूरु **राजभाषा के महत्व** विषयों पर सत्र संचालन करने हेतु हमारे बीच उपस्थित हैं।

डॉ. आनंद कुमार शर्मा, उपनिदेशक, एम.एस.ए., ने अध्यक्षीय भाषण में कहा कि अंतरिक्ष विभाग, अंतरिक्ष कार्यक्रम के अनुसंधान एवं विकास कार्य की दिशा में निरंतर प्रयत्नशील है। इसके साथ-साथ राजभाषा कार्यान्वयन की दिशा में भी अत्यंत सक्रिय है। पिछले वर्षों की तुलना में हिन्दी में शासकीय काम की मात्रा बढ़ गई है। प्रत्येक केन्द्र के अधिकारियों को इसे बहुत ही गंभीरता से लेना होगा, जिसके परिणामस्वरुप कार्यालय के सभी स्टॉफ सदस्यों में भी इसके प्रति जागरुकता बढ़ेगी और राजभाषा हिन्दी का विकास होगा। उन्होंने विभिन्न केन्द्र/यूनिटों से आए हुए राजभाषा कर्मियों को शुभकामनाएँ दी और इस कार्यक्रम का पूरा लाभ प्राप्त करने को कहा।

श्री बी.आर. राजपूत, संयुक्त निदेशक (राभा), अंतरिक्ष विभाग ने अपने भाषण में कहा कि समय-समय पर राजभाषा अभिमुखीकरण कार्यक्रमों के आयोजन से इसरो के सभी राजभाषा परिवार को एकत्रित होने का अवसर मिलता है। तथा ऐसे कार्यक्रमों के माध्यम से ही राजभाषा कर्मी अपने केन्द्र तथा यूनिटों को वापस लौटकर हिन्दी कार्यान्वयन को और भी प्रभावी रुप से लागू करने हेतु नए-नए विचारों को जानने के लिए एक अच्छा साधन होता है। तदनंतर उन्होंने अपने सेवाकाल के दौरान के कई महत्वपूर्ण संदर्भों के बारे में बताया कि किस तरह अंतरिक्ष कार्यक्रमों के उपयोग को देश के दूर-दराज स्थानों में पहुँचाया गया था।

श्रीमती सरला, वरिष्ठ हिन्दी अधिकारी, आईज़ेक ने धन्यवाद ज्ञापन प्रस्तुत किया। उन्होंने निदेशक महोदय डॉ. एम. अण्णादुरै जी को कृतज्ञता प्रकट की, कहा कि बहुत ही कम समय में इस कार्यक्रम का आयोजन किया गया, जिसका पूरा श्रेय निदेशक महोदय को जाता है। उन्हीं के मार्गदर्शन में यह कार्यक्रम निर्बाध रुप से आयोजित किया जा सका। उन्होंने सत्र संचालन करने हेतु श्री राधेश्याम गुप्ता तथा श्री अशोक कुमार बिल्लूरे तथा सैक अहमदाबाद, एस.डी.एस.सी.-शार, वी.एस.एस.सी-तिरुवनंतपुरम, एन.आर.एस.सी, हैदराबाद, अड्रिन-सिकंदराबाद, एल.पी.एस.-वलियमला/बेंगलूरु, एन.ए.आर.एल.-गादंकी, मुख्य नियंत्रण सुविधा-हासन, अंतरिक्ष

विभाग/इस्ट्रैक/आर.आर.एस.सी./लियोस, बेंगलूरु, से आए हुए सभी राजभाषा कर्मियों को तथा आईज़ेक के विभिन्न आमंत्रितों एवं प्रतिभागियों को बहुत-बहुत धन्यवाद दिया।

उद्घाटन सत्र के तदुपरांत श्री राधेश्याम गुप्ता, विशेष कार्याधिकारी व हिंदी अधिकारी-II, पी.आर.एल., अहमदाबाद ने **Google Voice typing & Machine translation** विषय पर सत्र संचालन किया। उन्होंने गूगल के ज़रिए हिन्दी अनुवाद करने हेतु विभिन्न steps के बारे में जानकारी दी।

अपराह्न सत्र में श्री अशोक कुमार बिल्लूरे, सेवा निवृत्त संयुक्त निदेशक (राभा.), बेंगलूरु ने **राजभाषा के महत्व** विषय पर सत्र संचालन किया।

अंत में सभी प्रतिभागियों को प्रमाण-पत्र वितरित किए गए। श्रीमती लक्ष्मी देवी, हिन्दी अनुवादक ने कार्यक्रम के दौरान मंच संचालन किया।

हिंदी कार्यशाला रिपोर्ट

भारत सरकार, राजभाषा विभाग तथा संसदीय राजभाषा समिति के निदेशों के अनुसार, हिन्दी के प्रगामी प्रयोग को बढ़ावा देने हेतु केन्द्र द्वारा हर तिमाही में अधिकारी/कर्मचारियों के लिए हिंदी कार्यशाला का आयोजन किया जाता है। इस संबंध में, इसरो उपग्रह केंद्र द्वारा दिनांक 02.03.2017 को तकनीशियन एवं ड्रॉफ्ट्समैन के लिए एक हिंदी कार्यशाला का आयोजन किया गया। सर्वप्रथम, श्री. शारिख, हिंदी टंकक ने हिंदी अधिकारी एवं प्रतिभागियों का स्वागत किया। श्रीमती गीता प्रसाद, हिंदी अधिकारी, आईज़ेक ने सत्र का संचालन किया। कार्यशाला के दौरान संकाय सदस्य ने राजभाषा के महत्व को बताते हुए राजभाषा के नीति, नियमों एवं अधिनियमों पर प्रकाश डालते हुए विभाग में लागू विभिन्न प्रोत्साहन योजनाओं एवं प्रशिक्षण के बारे सभी प्रतिभागियों को अवगत कराया और साथ ही उन्होंने **"दैनंदिन कार्य में हिंदी का प्रयोग"** विषय पर व्यावहारिक रूप से प्रशिक्षणार्थियों को विस्तृत ज्ञानवर्धक जानकारी प्रदान की।

इस कार्यशाला में कुल 36 प्रतिभागियों ने भाग लिया। श्री. मनोहर एल वाणियर, वरिष्ठ प्रधान, कार्मिक व सामान्य प्रशासन ने कार्यशाला के समापन समारोह की अध्यक्षता की। उन्होने सभी प्रतिभागियों से अपील किया कि अपना दैनंदिन शासकीय कार्य हिंदी में करें और अपने सहकर्मियों के साथ हिन्दी में वार्तालाप करें तथा आकस्मिक अवकाश, अर्जित अवकाश, चिकित्सा बिल, भविष्य निधि, अग्रिम आवेदन आदि मुद्रित प्रपत्रों को हिन्दी में भरें। तदनंतर वरिष्ठ प्रधान, कार्मिक व सामान्य प्रशासन ने अपने कर-कमलों से सभी प्रतिभागियों को प्रमाण पत्र प्रदान किया। कार्यशाला के अंत में श्री. शारिख, हिंदी टंकक ने सभी का आभार प्रकट किया।

मासिक प्रतियोगिताएँ

जनवरी 2017

संघ सरकार की नीति के अनुसार राजभाषा के प्रचार-प्रसार एंव विकास की गति बढ़ाने हेतु 06 जनवरी 2017 को केन्द्र के पदाधिकारियों के लिए **हिंदी प्रश्नोत्तरी** प्रतियोगिता का आयोजन किया गया। श्री आशीष पाण्डेय, लेखा अधिकारी तथा श्री देबी प्रसाद प्रधान, वरिष्ठ सहायक ने उक्त प्रतियोगिता का आयोजन किया। प्रतिभागियों ने बड़े ही उत्साह से प्रतियोगिता मे भाग लिया और पुरस्कार प्राप्त किए

फरवरी 2017

केन्द्र में 27 फरवरी 2017 को पहली बार विशेषकर प्रशासन क्षेत्र (प्रशासन, लेखा, क्रय, भण्डार) के सहायक/वरिष्ठ सहायक/वरिष्ठ परियोजना सहायकों के लिए **हिंदी वार्तालाप प्रतियोगिता** का आयोजन किया गया। यह टीम प्रतियोगिता थी। प्रतिभागियों को अलग-अलग विषयों पर हिंदी में वार्तालाप करने के लिए अवसर प्रदान किया गया। सभी ने बड़े ही उत्साह से उक्त प्रतियोगिता में भाग लिया तथा प्रशासन क्षेत्र के 12 पदाधिकारियों ने पुरस्कार प्राप्त किए। श्री तबरेज़ अली तोटद, वरिष्ठ लेखा अधिकारी, तथा श्रीमती गीता प्रसाद, हिंदी अधिकारी निर्णायक के रुप में उपस्थित रहे।

मार्च 2017

केन्द्र में 14 मार्च 2017 को तकनीकी क्षेत्र के तकनीशियन/ड्राफ्टस्मैन के लिए **हिंदी श्रुतलेखन प्रतियोगिता** का आयोजन किया। श्रीमती सुजाता कुमारी एम., वरिष्ठ हिंदी अनुवादक एवं श्रीमती लक्ष्मी देवी, कनिष्ठ हिंदी अनुवादक ने उक्त प्रतियोगिता का आयोजन किया। प्रतिभागियों ने पुरस्कार प्राप्त किए

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Purchase

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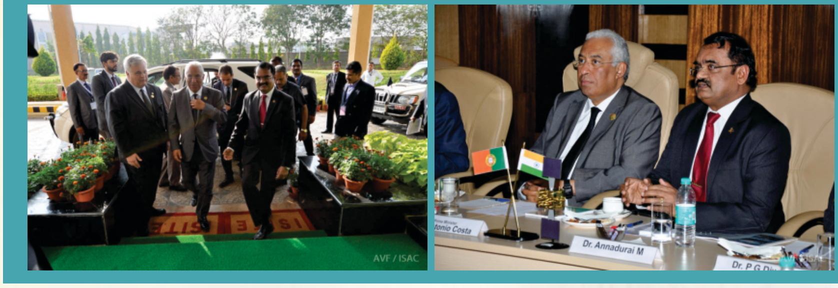
Sr. Proj. Attendant,
Medical

Kathirvelu C
Junior Engineer,
SEG-SPA

Visit of Parliamentatry Committee for Women Empowerment

Visit of JAXA delegation to ISITE

Visit of Honourable Portugal Prime Minister & his Delegation



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